THE

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A

DICTIONARY

OF

CIENCES, AND GENERAL LITERATURE

NINTH EDITION

VOLUME IV

DINBURGH: ADAM AND CHARLES BLACK

MDCCCLXXVI

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ENCYCLOPÆDIA BRITANNICA.

BOKHARA

BOKHARA, Bukhara, or Bukharia, a country and khanate of Central Asia, in Turkistan or Independent Tartary, lying between lat. 37° and 41° N., and long. 62° and 69° E. Its extent has been greatly diminished during recent years both on the N. and S.,—in the former direction by the conquests of Russia, and in the latter by the encroachments of Afghanistan. A considerable stretch of country, including the important towns of Balkh, Andkhoi, and Meimene, was at various times regarded as an integral part of the khanate; but at present the River Oxus forms for the most part its southern boundary. To the W. it is conterminous with the khanate of Khiva and the desert of Kharezm, which now form part of the Russian empire; and on the E. it stretches to the khanates of Kunduz and Khokand. Its area is estimated at 100,000 square miles. A large part of the western half of the land consists of a desolate steppe of argillaceous clay, broken by hills of slate and bare granite rocks; the eastern parts are occupied by offshoots of the Hindu-Koh and Tien-shan ranges, and the Pamir steppe. The cultivated land is confined almost entirely to the immediate neighbourhood of the rivers, of which the most important are the Amu or Oxus, the Zer-Affshan, and the Karshee. The Amu (Jihon or Kohik), which only belongs to the khanate in the middle part of its course, flows from S.E. to N.W., and varies in width from 300 to upwards of 800 yards. The Zer-Affshan, inferior to the Amu in the volume of its waters, and superior to it in the populousness and cultivation of its banks, rises in the high lands east of Samarkand, and, passing north of that city and of Bokhara, forms a lake in the province of Karakul about 25 miles in length. Its whole course is about 340 miles. The Karshee rises in the mountains to the S.E. of Samarkand, and passes through Shehr-Sebz and Karshee, below which it is lost in the desert.

There are no gold mines in Bokhara, but that metal is found among the sands of the Oxus in greater abundance, perhaps, than in any of the other rivers which flow from the Hindu-Koh. The climate of Bokhara is exposed to great variations. In summer the heat is often very great, and in winter the cold is proportionally severe. The frosts commence about the end of November, and continue till towards the end of April. The Amu is generally frozen over for some weeks in winter so as to be passable for caravans. In the desert the heat in summer exceeds 100° Fahr. Thunder-storms and earthquakes are not unfrequent, especially in the spring; and there are sometimes violent tornadoes, generally blowing from the N.W.

Inhabitants.

The population of Bokhara, composed of Tadjiks, Arabs, Uzbeks, Turkomans, Persians, Mervi, and Jews, may be estimated at between 1,000,000 and 2,000,000. Meyendorff estimates it at 2,478,000, Khanikoff at from 2,000,000 to 2,500,000, Burnes at less than 1,000,000, and Wolff at 1,200,000. The Tadjiks are the aborigines of the country, and are said to have come from the west, and settled on the banks of the Zer-Affshan at a time when the country was uninhabited, and a jungle of reeds covered the place where the town of Bokhara now stands. Except in the town of Bokhara, where they constitute the majority of the population, there are few Tadjiks now in the khanate. They are mostly engaged in commerce, are peaceful or even cowardly in their disposition, and are characterized by avarice, faithlessness, and deceit. They are usually tall, with handsome and regular features, fair complexion, and black eyes and hair. The number of Arabs, though not considerable, exceeds that of the Tadjiks. They are the descendants of the followers of Kutribe, who conquered the country about the beginning of the 8th century, and compelled the inhabitants to adopt the Mahometan faith. Their numbers are stated at 60,000, and they inhabit the northern part of the khanate, especially the neighbourhood of Vardanzi and Vafkend. Like their ancestors they still continue to lead a wandering life, their chief occupation being the tending of their flocks. Their moral qualities seem to be of a higher character than those of the Tadjiks. The Uzbeks, the last people that conquered this country, are the most numerous, and are at present the dominant race. They are divided into a number of tribes, of which the principal is that of Manghit. To it the reigning dynasty belongs. Some of the Uzbeks are nomadic in their habits, others are engaged in agriculture or live in towns. They are more bold and straightforward in their manners than the Tadjiks, but have unfortunately degenerated from contact with that race. There are a considerable number of Persians in Bokhara, most of whom have been brought as slaves from their native country. They are readily distinguished by the regularity of their features, and their bushy black

hair. Large numbers of them rise by their intelligence and faithfulness to occupy important situations. Although outwardly conforming to the faith and manners of the country, they cordially hate the native races, and are ready to hail with joy any political revolution which might shake the power of the Uzbeks. The Jews, though long established in the country, form but a very inconsiderable part of its inhabitants. They are chiefly to be found in Bokhara and some of the larger towns, where they have separate quarters assigned to them. Their privileges are very restricted The Mervi, who number about 40,000, are the people who were transplanted from the city of Merv on its destruction about 1810 by Emir Said Khan. The Turkoman and Kirghiz part of the population is wholly nomadic, and is chiefly to be found in the regions south of the Oxus.

Vegetable products.

The orchards in the neighbourhood of the larger towns are numerous and highly cultivated. They produce grapes, figs, peaches, pomegranates, apricots, plums, apples, pears, and quinces. The cultivation of cotton, tobacco, and lucerne is extensively carried on, as is also that of the mulberry, beet, cabbage, carrots, radishes, onions, cucumbers, pease, beans, lentils, melons, and pumpkins. The soil being of a saline nature requires to be cultivated with some care, so that it is found to be much more profitably laid out in gardens than in fields; indeed, the returns from the former exceed by sevenfold the returns from the same quantity of the latter. Wheat, rice, barley, millet, and joar (*Sorghum vulgare*) are the principal kinds of grain grown. The last-named is one of the most useful productions of the khanate, and as it is cheap and nutritious, it forms the chief subsistence of the poor.

Animals.

The horses of Bokhara are numerous, but are more remarkable for strength than for beauty. Asses are also very plentiful, and are large and sturdy. The camels, by means of which the entire traffic of Bokhara is carried on, are reared chiefly by the wandering tribes, particularly the Turkomans. They have a sleek coat as fine as that of a horse, and shed their hair in summer; from the hair a fine waterproof cloth of close and rather heavy texture is manufactured. The goats are about the common size, of a dark colour, and yield a shawl-wool inferior only to that of Kashmir. The bulls and cows are miserably small, and in very wretched condition. The rearing of sheep is much attended to, particularly by the Arabs. There is a peculiar breed, said to thrive only in the district of Karakul, which produces a jet-black curly fleece that is much valued. The wild animals are few. Tigers of a diminutive species are found in the valley of the Oxus; wild hogs, herds of deer, antelopes, and the wild ass roam on the plains; and foxes, wolves, jackals, and ounces are found in some parts. All kinds of game are scarce. The scorpion is common. The most valuable insect is the silkworm, which is reared in all parts of the khanate where there is water—every rivulet being lined with the mulberry.

Commerce.

Bokhara owes its importance to its central position. Lying on the route between Europe and the richest part of Asia, it is the seat of a considerable transit trade. The Government has established custom-houses, built caravanserais, and constructed cisterns along such caravan roads as are insufficiently supplied with water, but otherwise does nothing to encourage traffic; and the roads are generally in a wretched condition. Religious fanaticism formerly rendered it impossible for any except Mahometan merchants to trade with safety in the country; but since 1868 all at least who are in any way under the protection of Russia have full freedom to import or transport their wares throughout the country. Bokhara carries on an extensive trade with Russia by means of caravans, which travel by the following routes, viz.,—by the route of Khiva to the shores of and across the Caspian from and to Astrakhan; by the route to and from Orenburg by land in sixty days, through Orghenj in Khiva; to and from Troidska in Tobolsk, by the route east of the Sea of Aral, in forty-nine days; and to and from Petropavlosk (Kizil Djar) in ninety days. From 5000 to 6000 camels are annually employed in this trade. Bokhara exports to Russia, besides cotton, which is the principal item, dried fruits, rice, raw and dyed silks, indigo, silk sashes, turquoises, shawls, and furs. It imports muslins, calicoes, chintzes, some silk stuffs, broad-cloth, brocades, hides, iron, and other metals. The trade with Khiva employs only from 1000 to 1500 camels, and consists chiefly in exporting to Bokhara Russian goods, of which there is always an available surplus in the markets of Khiva. Three, and occasionally four, caravans arrive annually from Meshid in Persia, bringing cotton and silk stuffs, calicoes, chintzes, muslins, carpets, shawls, turquoises and opium, and receiving in return lamb-skins, cotton, rice, &c. From Herat and Kashmir is imported a considerable quantity of shawls and Indian produce and English manufactures from Kabul. A brisk traffic is also carried on with Khokand, Tashkand, Kashgar, and Yarkand. The central points of commerce are Bokhara and Karshee; and trade is principally conducted at the marts and fairs that are held in various parts of the country. Almost the only manufactures carried on in Bokhara are those of cotton goods, silks, carpets, leather, hardware, and jewellery. There is one manufactory of cast-iron articles. Swords and knives are fabricated at Hissar and Karshee, and excellent paper of raw silk at Bokhara.

Education.

Bokhara has for ages been reckoned the centre of Mussulman erudition; and if we look at the number of its schools and the state of education among its people, we cannot but admit that, in that respect, it ranks first among the states of Central Asia. About one-fourth of the population is said to be able to read and write. The primary schools are numerous in the capital, as well as in the other cities, and even in villages. The course in these schools extends over about seven years. Those wishing to continue their studies then enter the *medresses*, or seminaries, in which they pursue a higher course of studies, chiefly theological, under one or two professors who have acquired the right to give lectures. Each establishment has a fixed number of students, according to the extent of the building. Fifteen or even twenty years are reckoned insufficient to go through a complete course in these institutions. The people are, however, very superstitious, believing in witchcraft, omens, spirits, and the evil eye.

Government.

The Government is a hereditary despotism, the khan having the power of life and death over his subjects. The civil administration is in the hands of the clergy, and is founded on the Koran and the commentaries upon it. The military and civil dignitaries are divided into three grades. The troops of the khan are estimated at about 40,000 men, but of these not more than one-third are completely armed. The languages in use are the Persian and Turkoman; the latter is spoken by the Uzbeks, and the wandering tribes south of the Oxus.

History.

Bokhara was known to the ancients under the name of Sogdiana. It was too far removed to the east ever to be brought under the dominion of Rome, but it has shared deeply in all the various and bloody revolutions of Asia. It is mentioned by the earliest historical writers of Persia; and the foundation of the capital is ascribed to Efrasiab, the great Persian hero. About the year 856, Yacub-bin-Leis is said to have been invested with the government of that province by the caliph. About twenty years later it was conquered by Ismael, the first sovereign of the Sassanean dynasty, whose successors held it until the renowned Malek Shah, third of the Seljuk dynasty

of Persia, passed the Oxus about the end of the 11th century, and subdued the whole country watered by that river and the Jaxartes. In 1216 Bokhara was again subdued by the celebrated Mahomet Shah Kharezm, who enjoyed his conquest but a short time ere it was wrested from him by Genghis Khan in 1220. The country was wasted by the fury of this savage conqueror, but recovered something of its former prosperity under Octai Khan, his son, whose disposition was humane and benevolent. His posterity kept possession till about 1400, when Timur bore down everything before him. His descendants ruled in the country until about 1500, when it was overrun by the Usbek Tatars, under Ebulkhier Khan, the founder of the Sheibani dynasty, with which the history of Bokhara properly commences. The most remarkable representative of this family was Abdullah Khan, who greatly extended the limits of his kingdom by the conquest of Badakhshan, Herat, and Meshed, and greatly increased its prosperity by the public works which he authorized. Before the close of the century, however, the dynasty was extinct, and Bokhara was at once desolated by a Kirghiz invasion and distracted by a disputed succession. At length, in 1598, Baki Mehemet Khan, of the Astrakhan branch of the Timur family, mounted the throne, and thus introduced the dynasty of the Ashtarkhanides. The principal event of his reign was the defeat he inflicted on Shah Abbas of Persia in the neighbourhood of Balkh. His brother Veli Mehemet, who succeeded Baki in 1605, soon alienated his subjects, and was supplanted by his nephew Imamkuli. After a highly prosperous reign this prince resigned in favour of his brother, Nezr Mehemet, under whom the country was greatly troubled by the rebellion of his sons, who continued to quarrel with each other after their father's death. Meanwhile the district of Khiva, previously subject to Bokhara, was made an independent khanate by Abdulgazi Bahadur Khan; and in the reign of Subhankuli, who ascended the throne in 1680, the political power of Bokhara was still further lessened, though it continued to enjoy the unbounded respect of the Sunnite Mahometans. Subhankuli died in 1702 at the age of 80, and a war of succession broke out between his two sons, who were supported by the rivalry of two Usbek tribes. After five years the contest terminated in favour of Obeidullah, who was little better than a puppet in the hands of Rehim Bi Atalik, his vizier. The invasion of Nadir Shah came to complete the degradation of the land; and in 1740 the feeble king Ebulfeiz paid homage to the conqueror, and was soon after murdered and supplanted by his vizier. The time of the Ashtarkhanides had been for the most part a time of dissolution and decay; fanaticism and imbecility went hand in hand. On its fall the throne was seized by the Manghit family in the person of Mir Maasum, who pretended to the most extravagant sanctity, and proved by his military career that he had no small amount of ability. He turned his attention to the encroachments of the Afghans, and in 1781 reconquered the greater part of what had been lost to the south of the Oxus. Dying in 1802 he was succeeded by Saïd, who in bigotry and fanaticism was a true son of his father. In 1826 Nasrullah Bahuder mounted the throne, and began with the murder of his brother a reign of continued oppression and cruelty. Meanwhile Bokhara became an object of rivalry to Russia and England, and envoys were sent by both nations to cultivate the favour of the emir, who treated the Russians with arrogance and the English with contempt. The Russian armies were gradually advancing, and at last they appeared in Khokand; but the new emir, Mozaffer-eddin, instead of attempting to expiate the insults of his predecessor, sent a letter to General Chernayeff summoning him to evacuate the country, and threatening to raise all the faithful against him. In 1866 the Russians invaded the territory of Bokhara proper, and a decisive battle was fought on 20th May at Irdjar on the left bank of the Jaxartes. The Bokharians were defeated; but after a period of reluctant peace they forced the emir to renew the war. In 1868 the Russians entered Samarkand (May 14) and the emir was constrained to submit to the terms of the conqueror. Bokhara, though still nominally independent, is in reality subject to Russia, which must ere long absorb it completely.

Hitherto European intercourse with Bokhara has been very slight, and few travellers have personally visited it. The Brothers Polo were there in the time of Borak Khan (1264–1274) and Anthony Jenkinson in 1558–9, Cladisheff in 1740, Meyendorff and Nagri in 1820, Burnes in 1832, Wood in 1838, Khanikoff and Lehmann in 1841–2, Stoddart and Conolly in 1842, Danilevsky in 1842–3, and Vambery in 1863.

See Khanikoff's *Bokhara*, translated by De Bode (1845); Vambery, *Travels in Central Asia* (1864), *Sketches of Central Asia* (1868), and *History of Bokhara* (1873); Fedchenko's "Sketch of the Zarafshan Valley" in *Journ. R. Geogr. Soc.* for 1870; Hellwald, *Die Russen in Central Asien* (1873).

BOKHARA, or BUKHARA, the capital of the above khanate, is situated six or seven miles from the left bank of the Zer-Affshan, in 39° 48′ N. lat. and 64° 26′ E. long. It is about eight miles in circumference, has a triangular shape, and is surrounded by an earthen wall about 20 feet high, which is pierced by eleven gates. It is divided into two main portions known as the Deruni Shehr and Beruni Shehr, or the inner and outer city, and these are subdivided into several districts. Of the former splendours of "Bokhara the Noble" the remains are comparatively few, and the general appearance of the city is very disappointing. Vambery describes it as one of the dirtiest and most unhealthy places in all Asia. The streets are extremely narrow, and the houses, flat-roofed and built of sun-dried bricks on frameworks of wood, are small and only one story in height. The bazaars are very numerous, and each trade has its own. There are about thirty small caravanserais throughout the city, which serve partly as store-rooms and partly as inns. The largest building in Bokhara is the Mosque of Kelan, which was originally built by Timur, and was restored by Abdullah Khan. It occupies a square of 300 feet, and is surmounted by a dome 100 feet high. There the khan comes to pay his devotions on Fridays in the midst of his subjects. Among the other mosques, which are fabulously said by the inhabitants to number 365, the most important are the Mesdjidi Mogak, a subterranean building of uncertain origin, and the Divanbeghi, which dates from 1629. In the neighbourhood of the latter is an open square, with a reservoir in the middle, which forms one of the favourite lounges of the people of Bokhara. On the opposite side rises the ark or palace of the khan, a gloomy building on an elevated site. Bokhara has long been regarded as the intellectual centre of Central Asia, and possesses a large number of educational establishments. There is hardly a street without its school, and the number of colleges or *medresses*, set down too at 365 by the inhabitants, is really about 80. Of these the handsomest is Abdullah's, which was built in 1372, and contains about 100 cells. Others date from 1426, 1529, and 1582; and one was founded by the Empress Catherine of Russia. The water supply of Bokhara is very defective, and the canals that convey it from the river are left in such an extreme state of filthiness, as readily to account for the prevalence of many forms of disease. The population was estimated by Meyendorff at about 70,000, and in this he was supported by Moorcroft and Khanikoff. Burnes raised the number to 150,000, and Wolff to 180,000; but it is now stated by Vambery at no more than 30,000.

BOLBEC, a town of France, capital of a canton in the department of Lower Seine, 18 miles E.N.E. from Havre on the railway to Paris, which here passes over high embankments and a viaduct. It was burned almost to the ground in 1765, but is now a flourishing brick-built manufacturing town, well supplied with water-power by the Bolbec stream. The principal manufactures are cotton goods, woollen cloth, and leather; there are also linen factories and dye-works. Population in 1872, 9019.

BOLEYN, ANNE, or, as the name is variously spelled, Bullen, Bouleyn, Boullan, or Boulain, queen of England, and second wife of Henry VIII., was the daughter of Sir Thomas Boleyn, a distinguished politician, and Lady Elizabeth Howard, daughter of the earl of Surrey, afterwards duke of Norfolk. Considerable obscurity rests over the date of her birth, which has been variously stated as 1501 and 1507; perhaps the earlier date is the more probable. She received a very careful education, and in 1514 became maid-in-waiting to Mary Tudor, then the affianced bride of Louis XII. of France. She crossed to France in Mary's train, but did not return with her, having entered the service of Queen Claude, where she was celebrated for her beauty, talents, and accomplishments. The period of her return to England has been matter of dispute; some, following Herbert and others, would make the date about 1522, others 1527. It may be assumed with some confidence that she returned about the earlier date. About this time occurred her love affair with Percy, afterwards earl of Nort umberland, which was broken off by Wolsey, acting apparently under the directions of the jealous king. Henry seems already to have begun to direct his affections towards the fair Boleyn, who was then one of the maids of honour attached to his consort, Katherine of Aragon. He advanced her family, but is said to have been repulsed by her when he made an offer of his love. In 1527, after some absence from the court, she seems to have returned, and Henry's attentions to her became more marked than before. His passion soon opened his eyes more clearly to the sin of his marriage with his deceased brother's wife, and the subject of the divorce began to be seriously discussed. Towards 1530 Anne Boleyn was accustomed to keep state almost as queen; in 1532 she was raised to the peerage with the title of marchioness of Pembroke, and accompanied Henry in his visit to France. On January 25, 1533, according to a contemporary report, her ambition was crowned by a private marriage with Henry. On the 12th of April she was openly proclaimed queen, and the marriage was again solemnized; and on the 8th of May the king's previous marriage was declared to have been null and void. The coronation took place on the 19th of May, and on the 7th September, a princess, the famous Elizabeth, was born.

Little is known of the new queen's married life. She to some extent favoured the Reformers, and countenanced the translation of the Bible. In January 1536 she gave birth to a prince, still-born. It is said that this mishap was occasioned by her suddenly becoming aware of Henry's attentions to Lady Jane Seymour. However this may be, Henry's superstitious fears seem to have been roused by the want of a male heir, and his fancy for Anne Boleyn had been replaced by a new passion. In April 1536 a committee sat privately to inquire into certain accusations of adultery against the queen. A special commission was called on the 24th April, and orders were issued for the arrest of the Viscount Rochford, the queen's brother, Sir Henry Norris, Sir Wm. Brereton, Sir Francis Weston, and Mark Smeton, all her alleged paramours. At the same time writs were issued for a new parliament. On the 2d May the queen was arrested and summoned before the privy council. Smeton, Norris, and Weston were afterwards examined, and of these Smeton confessed, though it was said under torture. Norris is thought to have made some admission, which, however, he afterwards withdrew. All three were committed to the Tower, to an apartment in which the queen was also consigned. Henry wrote to her, holding out hopes of pardon if she would be open and honest. Her reply, however, strongly affirms her innocence, and its general tone goes far in her favour. (The authenticity of the queen's letter has been doubted, though on slight grounds, by Mr Froude.) The juries of Middlesex and Kent, before whom proceedings opened, found true writs charging the queen with adultery, committed with the above-named Rochford, Brereton, Weston, Norris, and Smeton, and all with conspiring against the king's life. On the 12th May, Brereton, Norris, Weston, and Smeton were tried at Westminster, found guilty, and condemned. On the 15th Anne Boleyn and her brother were tried before twenty-seven peers, found guilty, and sentenced. On the 17th Smeton was hanged, the others beheaded. Their remarks on the scaffold were general, and can be interpreted fairly in neither way. Before the queen's execution she is said to have confessed to Cranmer some previous impediment which rendered her marriage with the king null and void, but what the confession was is absolutely unknown. On the 19th May she suffered death on Tower Green. On the next day Henry was married to Jane Seymour. Over the whole episode of Anne Boleyn's trial and execution the deepest obscurity rests. All traces of the evidence have vanished, and the conflicting judgments of historians, it must be confessed, seem generally to be determined by the bias of the individual writer.

See *State Trials*, where Burnet and the older writers are quoted; Strickland, *Lives of the Queens of England*; Miss Binger, *Life of A. Boleyn*; and the histories of Lingard and Froude.

BOLI, a town of Asiatic Turkey, in Anatolia, situated about 85 miles N.W. of Angora, on the Philios Chai, to the south of the Boli Dagh, in 31° 40′ E. long. and 40° 45′ N. lat. It is the capital of a sandjak and the seat of a governor, and contains a ruined castle and numerous mosques and baths, nowise remarkable in their structure. Cotton and leather are manufactured; the country around is fertile, and in the neighbourhood is a forest, from which Constantinople is largely supplied with wood. There are warm springs in the vicinity. Boli is built not far from what is regarded by Leake as the ruins of Hadrianopolis, where many marble fragments with Greek inscriptions are still found. The population is conjecturally stated at 10,000.

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acquire an equally high reputation for dissipation and licentiousness. He was the Rochester of the period, with more than Rochester's abilities. He sought and gained the fame of a modern Alcibiades or Petronius. Amidst all his excesses, however, he maintained a real interest in literature. He was intimate with Dryden, and prefixed a laudatory poem to the first edition of the translation of Virgil. The verses did not hold out high promise of poetic power; and his later efforts in the same direction did little for his literary reputation. His most considerable production, *Almahide, an Ode*, is a miserable tawdry affair; the light ode to the equally light *Clara* is very much better, and has some vivacity and sparkle. He seems to have been conscious of his want of poetic genius, for his verse remains are not numerous.

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The Tory party, from a combination of circumstances, were then all-powerful in the House of Commons. The Partition Treaty, a measure for which, indeed, little can be said, had not met with popular favour, while William's large grants to foreigners, together with the general coldness and repulsiveness of his manners, had rendered him most unpopular. A perfect storm of discontent had arisen, and the Tories were nearly bewildered with the power which had been suddenly placed in their hands. Harley, perhaps, at that time, from his moderation, the most influential man of the party, led the House as speaker. St John enrolled himself among the Tories with the utmost enthusiasm, and from the first displayed such brilliant powers as placed him at once in the front rank, and gave him an almost unique position. His youth and high birth, his handsome and commanding presence, and his agreeable address, no doubt contributed largely to his rapid elevation; but what above all secured for him an unequalled success was his wonderful eloquence. The powers he unexpectedly evinced as an orator and debater were unrivalled then, and, if we are to take contemporary reports as our authority, had never been equalled, and have seldom, if ever, been surpassed. Not a fragment of his many speeches has come down to us; but from the criticisms of those who heard him speak, and from his published writings, some idea of their general quality may be gathered. The most prominent characteristics seem to have been copiousness and readiness, extreme fluency, and spontaneity, combined with a brilliant felicity of phrase, the right expression seeming to spring up naturally along with the thought to be expressed. His sentences are mostly massive and balanced, yet never heavy; flowing, but rarely redundant. He is, perhaps, the first British statesman whose parliamentary oratory has been really a power; and with such splendid qualifications it was little wonder that he readily became the protagonist of the Tory party. He was their mouthpiece; he gave expression to their half-articulate wishes, hounded them on in their insane attacks on the great Whig leaders, and barbed their invectives with his own trenchant wit. But, as he has himself admitted, it would be difficult to discover what object the Tories really had in view. Their only desire seems to have been to revenge themselves upon their political opponents and indirectly to assail the king. A definite policy they had not either at that time or throughout the succeeding reign. The Whigs had so far a basis of operations; they held by the Protestant succession, and were in favour of a war with France. The Tories, who, if thoroughgoing, were really Jacobites, were averse to the French war, because it indirectly weakened their party, and they did not favour the succession. But consistent adherence to principle is a thing one looks for in vain among the majority of statesmen in the reign of Anne. There never was a time in British history when the movements of politicians were regulated by such petty causes, and when great talents had to be turned to such paltry purposes. Politics became but a grand game, in which success meant office, power, wealth, and dignity; and to secure such success few hesitated at the most dishonourable means. Treason was a thing of common occurrence, and many names among the highest in English history are tarnished by acts of grossest treachery. Bolingbroke participates to the full in the spirit of his time. Never throughout his whole career can one observe the operation of a consistent policy, or trace the action of any motive higher than personal ambition. Mentally and morally he was well qualified to take a prominent place in the political struggle of the time.

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BOLBEC, a town of France, capital of a canton in the department of Lower Seine, 18 miles E.N.E. from Havre on the railway to Paris, which here passes over high embankments and a viaduct. It was burned almost to the ground in 1765, but is now a flourishing brick-built manufacturing town, well supplied with water-power by the Bolbec stream. The principal manufactures are cotton goods, woollen cloth, and leather; there are also linen factories and dye-works. Population in 1872, 9019.

BOLEYN, ANNE, or, as the name is variously spelled, Bullen, Bouleyn, Boullan, or Boulain, queen of England, and second wife of Henry VIII., was the daughter of Sir Thomas Boleyn, a distinguished politician, and Lady Elizabeth Howard, daughter of the earl of Surrey, afterwards duke of Norfolk. Considerable obscurity rests over the date of her birth, which has been variously stated as 1501 and 1507; perhaps the earlier date is the more probable. She received a very careful education, and in 1514 became maid-in-waiting to Mary Tudor, then the affianced bride of Louis XII. of France. She crossed to France in Mary's train, but did not return with her, having entered the service of Queen Claude, where she was celebrated for her beauty, talents, and accomplishments. The period of her return to England has been matter of dispute; some, following Herbert and others, would make the date about 1522, others 1527. It may be assumed with some confidence that she returned about the earlier date. About this time occurred her love affair with Percy, afterwards earl of Nort umberland, which was broken off by Wolsey, acting apparently under the directions of the jealous king. Henry seems already to have begun to direct his affections towards the fair Boleyn, who was then one of the maids of honour attached to his consort, Katherine of Aragon. He advanced her family, but is said to have been repulsed by her when he made an offer of his love. In 1527, after some absence from the court, she seems to have returned, and Henry's attentions to her became more marked than before. His passion soon opened his eyes more clearly to the sin of his marriage with his deceased brother's wife, and the subject of the divorce began to be seriously discussed. Towards 1530 Anne Boleyn was accustomed to keep state almost as queen; in 1532 she was raised to the peerage with the title of marchioness of Pembroke, and accompanied Henry in his visit to France. On January 25, 1533, according to a contemporary report, her ambition was crowned by a private marriage with Henry. On the 12th of April she was openly proclaimed queen, and the marriage was again solemnized; and on the 8th of May the king's previous marriage was declared to have been null and void. The coronation took place on the 19th of May, and on the 7th September, a princess, the famous Elizabeth, was born.

Little is known of the new queen's married life. She to some extent favoured the Reformers, and countenanced the translation of the Bible. In January 1536 she gave birth to a prince, still-born. It is said that this mishap was occasioned by her suddenly becoming aware of Henry's attentions to Lady Jane Seymour. However this may be, Henry's superstitious fears seem to have been roused by the want of a male heir, and his fancy for Anne Boleyn had been replaced by a new passion. In April 1536 a committee sat privately to inquire into certain accusations of adultery against the queen. A special commission was called on the 24th April, and orders were issued for the arrest of the Viscount Rochford, the queen's brother, Sir Henry Norris, Sir Wm. Brereton, Sir Francis Weston, and Mark Smeton, all her alleged paramours. At the same time writs were issued for a new parliament. On the 2d May the queen was arrested and summoned before the privy council. Smeton, Norris, and Weston were afterwards examined, and of these Smeton confessed, though it was said under torture. Norris is thought to have made some admission, which, however, he afterwards withdrew. All three were committed to the Tower, to an apartment in which the queen was also consigned. Henry wrote to her, holding out hopes of pardon if she would be open and honest. Her reply, however, strongly affirms her innocence, and its general tone goes far in her favour. (The authenticity of the queen's letter has been doubted, though on slight grounds, by Mr Froude.) The juries of Middlesex and Kent, before whom proceedings opened, found true writs charging the queen with adultery, committed with the above-named Rochford, Brereton, Weston, Norris, and Smeton, and all with conspiring against the king's life. On the 12th May, Brereton, Norris, Weston, and Smeton were tried at Westminster, found guilty, and condemned. On the 15th Anne Boleyn and her brother were tried before twenty-seven peers, found guilty, and sentenced. On the 17th Smeton was hanged, the others beheaded. Their remarks on the scaffold were general, and can be interpreted fairly in neither way. Before the queen's execution she is said to have confessed to Cranmer some previous impediment which rendered her marriage with the king null and void, but what the confession was is absolutely unknown. On the 19th May she suffered death on Tower Green. On the next day Henry was married to Jane Seymour. Over the whole episode of Anne Boleyn's trial and execution the deepest obscurity rests. All traces of the evidence have vanished, and the conflicting judgments of historians, it must be confessed, seem generally to be determined by the bias of the individual writer.

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would evidently meet with popular approval, and Anne had therefore no hesitation in dismissing Godolphin and the Whigs. Harley became Chancellor of the Exchequer and virtually premier; St John was made Secretary of State.

The political problem, how, under all contingencies, to retain power, was somewhat complicated. The queen's health made the succession the main question. Now, the accession of the Elector meant the restoration of the Whigs to power. It was hardly possible for the Tory leaders to oust the Whig party from the graces of the House of Hanover, with whom their policy was so knit up. Prudence, therefore, as well as principle, made them lean towards the exiled House of Stuart, and for a time extreme Tory was synonymous with Jacobite. But the hopes of James to a great extent depended on the assistance of France, and consequently peace with France became their primary object. To attain it they were urged also by the loudly expressed wishes of a large section of the people, and by their hatred of the Whigs, with whom the war was identified. Active steps in the matter were taken mainly by St John, and in the beginning of 1712 he had at last brought affairs to such a pass that the duke of Ormond, who had superseded Marlborough, received secret orders not to attack the French, while private intimation of this order was sent to the French Government. Arrangements were then made with the French minister De Torcy, whereby the fundamental articles of the league with the allies were broken, Britain engaging to enter into a separate peace with France, receiving certain special advantages, and quietly abandoning some of the allies, as the Catalans. Nothing can possibly extenuate the baseness of these proceedings, and our judgment of them cannot be altered by our opinion as to the advisability of the peace. The Whig party were wholly unable to throw any obstacles in the way; their majority in the House of Lords had been swamped by the creation of twelve new peers; and Walpole had been impeached on a petty charge and committed to the Tower. Finally, St John, now Viscount Bolingbroke, visited Paris to push on negotiations so that peace might be announced to next Parliament. It has been said, though he himself denied it, that during this visit he had interviews with the Pretender. In April 1713 the famous treaty of Utrecht was signed, and the Parliament of that year had the articles read to them. This, however, had not the effect anticipated by Bolingbroke. There was a lurking feeling of discontent with regard to it, and the commercial articles, bearing on trade with France, excited great indignation among the mercantile classes.

Bolingbroke and the Tories seemed, however, to be at the zenith of their power; but the foundations of that power were unstable, and there was dissension among the leaders. Harley had become earl of Oxford, and Bolingbroke was indignant at receiving only the rank of viscount. His anger was increased on failing to receive the garter vacant by the death of Godolphin. The disputes between the former allies became open and violent. By unscrupulous bribery Bolingbroke managed to secure the interest of Mrs Masham, and through her wrought upon the queen. In the Parliament of 1714 he dealt the death-blow to Oxford's power, by compelling him to vote upon the Schism Bill; and finally, on the 27th July, after a stormy discussion, which greatly excited the queen, Oxford was dismissed. Bolingbroke, however, had but a brief taste of power, for on the 30th the queen was seized with apoplexy. At the council held upon the emergency the dukes of Argyle and Somerset boldly presented themselves, and proposed and carried a resolution that the duke of Shrewsbury should be recommended as Lord Treasurer. Bolingbroke was obliged to yield. Anne was able to give assent; the Whig party had already made all their arrangements, and immediately on the queen's death (August 1) the Elector was proclaimed king, and special messengers were despatched to bring him over. Bolingbroke and his friends seemed bewildered; they were, indeed, thoroughly taken by surprise, and their half-formed schemes disconcerted. Atterbury alone urged Bolingbroke boldly to proclaim James, but either the courage of the latter failed, or, as is more probable, his intentions were not sufficiently definite. It is not an unreasonable supposition that, had a fair time been granted to him, he would have endeavoured to make favour with the House of Hanover. Any such hope was then out of the question; the duties of his office were transferred temporarily to Addison, and within the month in which the queen died he was formally dismissed. It was soon known that the new Parliament, who were mainly Whigs, intended to impeach Oxford and Bolingbroke for their share in the recent peace. From what we now know of the actual accusation, it is plain that it did not amount to high treason. Had there been nothing farther it would have been the best plan to have stayed and faced the trial. This, accordingly, was done by Oxford; but Bolingbroke, after showing himself ostentatiously in public, fled over to France in disguise, even before the impeachment had been made in the House. In the letter he left behind him for Lord Lansdowne he gives as his excuse that he had certain and repeated informations from some who were in the secret of affairs that a resolution was taken to pursue him to the scaffold. In the famous letter to Sir Wm. Windham he takes somewhat different ground, and accounts for his flight from his intense dislike of Oxford, and his resolution not to be associated with him in any way. It was not till the 10th June that he was formally impeached; on 6th August he was attainted and summoned to appear before the 10th September. On the 16th September, he not having made his appearance, his name was struck off the list of peers, and sentence of banishment was passed. Long before this, however, Bolingbroke had thrown in his lot with the Pretender. He had secret interviews with the duke of Berwick immediately after his arrival in Paris, while professing the most loyal sentiments to Lord Stair, the British ambassador, and in the month of July he was formally installed as Secretary of State to the prince. Whatever plans he might have hoped to carry through in this capacity were thoroughly thwarted by the numberless irregular agents and advisers who swarmed about the petty court, and by the impracticable disposition of the prince himself. The expedition to Scotland, undertaken against Bolingbroke's advice, proved a complete failure; and in February 1716 he was dismissed with scant ceremony from the prince's service, while a formal impeachment was drawn up, accusing him of dilatoriness and want of energy. Rumour was busy with his name, and every species of treachery was imputed to him. The celebrated letter to Sir Wm. Windham, in many respects the best of his writings, was drawn up in the following year, and contains an elaborate sketch of the events of his political career and a justification of his proceedings. The letter may have been circulated to a slight extent in print or in manuscript, but it was undoubtedly not made public till 1753, two years after Bolingbroke's death. It is a skilful piece of work, written with great apparent candour, but inconsistent with known facts, and throwing no satisfactory light on the complicated transactions in which the writer had been involved.

His efforts to ingratiate himself with the new dynasty in England were unavailing, and from this time onwards to his death he led a life of enforced inactivity. He was for ever debarred from the arena of political strife, and though he incessantly hovered round the outskirts, he was unable to effect an entrance. He plunged deeply into philosophical

studies, and would fain have had his friends believe that he had thoroughly and voluntarily resigned himself to a life of studious retirement. He took up his abode at La Source, and in 1720, two years after the death of his first wife, married the Marquise de Villette, for whom he seems to have had a sincere affection. In 1723, by bribing the duchess of Kendal, a removal of part of his sentence was attained; he was permitted to return to England, and, by a special bill, passed two years later, was allowed to enjoy his first wife's property. He bought a magnificent estate at Dawley; and, while keeping up the appearance of single-minded devotion to study, plunged eagerly into as much of political intrigue as was open to him. He had tried in vain to conciliate Walpole, and seems to have seen that during that minister's tenure of power he could never recover his position. He accordingly united himself to the dissatisfied section of the Whigs led by Pulteney, and tried to organize out of them and the remnant of the Tories an opposition to Walpole. His aid was lent not only in preparing speeches for Windham, Pulteney, and others, who for a time were little more than his mouthpieces, but in written attacks upon the minister. His papers in the *Craftsman*, which gave that journal a circulation exceeding even that of the *Spectator*, are masterpieces of vigorous English. In their collected form as the *Dissertation on Parties* and *Oldcastle's Remarks on History*, they are valuable contributions to our knowledge of the political movements of the period. At one time, indeed, it seemed that the opposition would succeed in driving Walpole from the field. The outcry against his Excise Bill was strong, and his majority in the House was seriously diminished, but he was too firmly rooted to be easily moved; and in 1735 he retaliated on Bolingbroke by a significant and threatening speech. So evident was it that he had obtained an insight into intrigues which could not stand investigation, that Bolingbroke took alarm and a second time fled to France. Other motives, such as pecuniary embarrassments, may have contributed to force him to this step, and there can be little doubt that his reputation was of a nature seriously to damage any party with whom he united. He found that Pulteney was anxious to get rid of him, and felt with some bitterness that, like an old actor, he must retire from the political stage before being hissed off. After this second retreat he settled at Chanteloup, in Touraine, whence he paid two or three visits to England. Finally, in 1743, after the death of his father, he took up his residence at Battersea, and, finding the new statesmen little disposed to hearken even to his counsels, endeavoured to devote himself entirely to philosophy. He died at Battersea on the 12th December 1751.

Of Bolingbroke as an author but little can be said. The question asked a very few years after his death, "Who now reads Bolingbroke?" may be put with tenfold significance now. The influence of his writings on English literature has been quite inappreciable, and probably the works of few men of such ability have been so little read. Yet this neglect is in some respects undeserved. His writings may be regarded in two aspects,—as specimens of English prose, and as positive contributions to history, politics, and philosophy. In the latter aspect their worth is indeed small. His historical treatises, while containing much that is of interest and importance, are over-weighted by the constant reference to the peace of Utrecht, the defence of which is almost their sole object. It would be difficult to extract from the *Dissertation on Parties*, the *Idea of a Patriot King*, or the *Letters on Patriotism* anything like a consistent philosophy of government. No one has expounded better than Bolingbroke the fundamental principles of Whig policy, and yet his ideal of a king is a sovereign who, from various qualities, is able to retain nearly absolute power, and to govern without the intervention of party spirit. In philosophy he occupies but a subordinate place in the long line of English writers who drew their inspiration from Locke, and who gave the key-note to the religious enlightenment of the 18th century. He is a deist, and from the basis of the sensational theory of knowledge attacks revealed religion with force quite inferior to Toland or Tindal. Bolingbroke's philosophical works are indeed insufferably wearisome, and it is only in them that his style ever flags and grows cumbersome, for his other writings are in many respects the perfection of English prose style, and can stand comparison even with the finished compositions of Addison. For ease, grace, and oratorical vehemence and energy, the *Letter to Sir Wm. Windham* and the dedication of the *Dissertation on Parties* are nearly unsurpassed. Bolingbroke clearly was at his best when roused by strong feeling, and his most vigorous passages are those which would naturally have been spoken. That none of his parliamentary orations have come down to us is matter of deepest regret, even though our estimate of them be lower than Pitt's.

Bolingbroke's works were published in 5 vols. 4to, by David Mallet, 1753-54. Later editions have generally prefixed to them the *Life* by Goldsmith, a compilation of little value. Two volumes of *Correspondence* were published by Parke in 1798. Materials for Bolingbroke's life are to be found in the Stuart papers, Marchmont papers, Coxe's *Life of Marlborough*, Swift's *Journal* and *History of the last Four Years of Queen Anne*, Somerville's *Queen Anne*, and Stanhope's *Reign of Queen Anne* and *History of England*, particularly vols. i. and ii. Some special information will be found in De Torcy's *Mémoires*, and Mignet's *Negociacions relatifs à la Succession d'Espagne*. See also G. W. Cooke, *Memoirs of Bolingbroke*, 2 vols., 1835; Rémusat, *Angleterre au XVIII Siècle*, vol. i.; Macknight, *Life of Bolingbroke*, 1863. (R. AD.)

BOLIVAR, Simon, the hero of South American independence, was born in the city of Caracas, Venezuela, on the 24th July 1783. His father was Juan Vicente Bolivar y Ponte, and his mother Maria Concepcion Palacios y Sojo, both descended of noble families in Venezuela. After acquiring the elements of a liberal education at home, Bolivar was sent to Europe to prosecute his studies, and with this view repaired to Madrid, where he appears to have resided for several years. Having completed his education, he spent some time in travelling, chiefly in the south of Europe, and visited the French capital, where he was an eye-witness of some of the last scenes of the Revolution. Returning to Madrid, he married, in 1801, the daughter of Don N. Toro, uncle of the marquis of Toro in Caracas, and embarked with her for America, intending, it is said, to devote himself to the improvement of his large estate. But this plan was frustrated by the premature death of his young wife, who fell a victim to yellow fever; and Bolivar again visited Europe, in order, by change of scene, to alleviate the sorrow occasioned by this bereavement.

On his return home in 1809 he passed through the United States, where, for the first time, he had an opportunity of observing the working of free institutions; and soon after his arrival in Venezuela he appears to have identified himself with the cause of independence which had already agitated the Spanish colonies for some years. Being one of the promoters of the movement at Caracas in April 1810, he received a colonel's commission from the revolutionary junta, and was associated with Luis Lopez Mendez in a mission to the court of Great Britain. Venezuela declared its independence of the mother country on July 5, 1811, and in the following year the war commenced in earnest by the advance of Monteverde with the Spanish troops. Bolivar was intrusted with the command of the important post of Puerto Cabello, but not being supported he had to evacuate the place; and owing to the inaction of Miranda the Spaniards recovered their hold over the country.

Like others of the revolutionists Bolivar took to flight,

and succeeded in reaching Curaçao in safety. He did not, however, remain long in retirement, but in September 1812, hearing of important movements in New Granada, repaired to Carthagena, where he received a commission to operate against the Spanish troops on the Magdalena River. In this expedition he proved eminently successful, driving the Spaniards from post to post, until arriving at the confines of Venezuela he boldly determined to enter that province and try conclusions with General Monteverde himself. His troops did not number more than 500 men; but, in spite of many discouragements, he forced his way to Merida and Truxillo, towns of some importance in the west of Venezuela, and succeeded in raising the population to his support. Forming his increased forces into two divisions, he committed the charge of one to his colleague Rivas, and pushing on for Caracas the capital, issued his decree of "war to the death." A decisive battle ensued at Lastoguanes, where the Spanish troops under Monteverde sustained a crushing defeat. Caracas was entered in triumph on the 4th of August 1813, and Monteverde took refuge in Puerto Cabello. General Mariño effected the liberation of the eastern district of Venezuela, and the patriots obtained entire possession of the country in January 1814. This success was, however, of very brief duration. The royalists, effectually roused by the reverses they had sustained, concentrated all their means, and a number of sanguinary encounters ensued. Bolivar was eventually defeated by Boves near Cura, in the plains of La Puerta, and compelled to embark for Cumana with the shattered remains of his forces. Caracas was retaken by the Spaniards in July; and before the end of the year 1814 the royalists were again the undisputed masters of Venezuela. From Cumana Bolivar repaired to Carthagena, and thence to Tunja, where the revolutionary congress of New Grenada was sitting. Here, notwithstanding his misfortunes and the efforts of his personal enemies, he was received and treated with great consideration. The congress appointed him to conduct an expedition against Santa Fé de Bogota, where Don Cundinamarca had refused to acknowledge the new coalition of the provinces. In December 1814 he appeared before Bogota with a force of 2000 men, and obliged the recalcitrant leaders to capitulate,—a service for which he received the thanks of congress. In the meanwhile Santa Martha had unfortunately fallen into the hands of the royalists, and Bolivar was ordered to the relief of the place. In this, however, he was not successful, General Morillo having landed an overwhelming Spanish force. Hopeless of the attempt, he resigned his commission and embarked for Kingston, Jamaica, in May 1814. While residing there an attempt was made upon his life by a hired assassin, who, in mistake, murdered his secretary.

From Kingston Bolivar repaired to Aux Cayes in Hayti, where he was furnished with a small force by President Petion. An expedition was organized, and landed on the mainland in May 1816, but proved a failure. Nothing daunted, however, he obtained reinforcements at Aux Cayes, and in December landed first in Margarita, and then at Barcelona. Here a provisional government was formed, and troops were assembled to resist Morillo, who was then advancing at the head of a strong division. The hostile forces encountered each other on the 16th of February 1817, when a desperate conflict ensued, which lasted during that and the two following days, and ended in the defeat of the royalists. Morillo retired in disorder, and being met on his retreat by Paez with his *llaneros*, suffered an additional and more complete overthrow. Being now recognized as commander-in-chief, Bolivar proceeded in his career of victory, and before the close of the year had fixed his headquarters at Angostura on the Orinoco. At the opening of the congress which assembled in that city on the 15th February 1819 he submitted an elaborate exposition of his views on government, and concluded by surrendering his authority into the hands of congress. Being, however, required to resume his power, and retain it until the independence of the country had been completely established, he reorganized his troops, and set out from Angostura, in order to cross the Cordilleras, effect a junction with General Santander, who commanded the republican force in New Grenada, and bring their united forces into action against the common enemy. This bold and original design was crowned with complete success. In July 1819 he entered Tunja, after a sharp action on the adjoining heights; and on the 7th of August he gained the victory of Bojaca, which gave him immediate possession of Bogota and all New Grenada.

This campaign is unquestionably Bolivar's most brilliant achievement, and deserves much of the praise which has been lavished on it. His return to Angostura was a sort of national festival. He was hailed as the deliverer and father of his country, and all manner of distinctions and congratulations were heaped upon him. Availing himself of the favourable moment, he obtained the enactment of the fundamental law of 17th December 1819, by which the republics of Venezuela and New Grenada were henceforth to be united in a single state, under his presidency, by the title of the Republic of Colombia. The seat of government was also transferred provisionally to Rosario de Cucuta, on the frontier of the two provinces, and Bolivar again took the field. Being now at the head of the most numerous and best appointed army the republicans had yet assembled, he gained important advantages over the Spaniards under Morillo, and on the 25th November 1820 concluded at Truxillo an armistice of six months, probably in the hope that the Spaniards would come to terms, and that the further effusion of blood might be spared. If such were his views, however, they were disappointed. Morillo was recalled, and General Torre assumed the command. The armistice was allowed to expire, and a renewal of the contest became inevitable. Bolivar therefore resolved, if possible, to strike a decisive blow; and this accordingly he did at Carabobo, where, encountering Torre, he so completely routed the Spaniards, that the shattered remains of their army were forced to take refuge in Puerto Cabello, where two years after they surrendered to Paez. The battle of Carabobo may be considered as having put an end to the war in Venezuela. On the 29th June 1820 Bolivar entered Caracas, and by the close of the year the Spaniards were driven from every part of the province except Puerto Cabello. The next step was to secure, by permanent political institutions, the independence which had been so dearly purchased; and, accordingly, on the 30th of August 1821, the constitution of Colombia was adopted with general approbation, Bolivar himself being president, and Santander vice-president.

There was, however, more work for him to do. The Spaniards, though expelled from Colombia, still held possession of the neighbouring provinces of Ecuador and Peru; and Bolivar determined to complete the liberation of the whole country. Placing himself at the head of the army, he marched on Quito in Ecuador. A severe battle was fought at Pichincha, where, by the prowess of his colleague Sucre, the Spaniards were routed, and Quito was entered by the republicans in June 1822. Bolivar then marched upon Lima, which the royalists evacuated at his approach; and entering the capital in triumph, he was invested with absolute power as dictator, and authorized to call into action all the resources of the country. Owing, however, to the intrigues of the republican factions in Peru he was forced to withdraw to Truxillo, leaving the capital to the mercy of the Spaniards under Canterac, by

whom it was immediately occupied. But this misfortune proved only temporary. By June 1824 the liberating army was completely organized; and taking the field soon after, it routed the vanguard of the enemy. Improving his advantage, Bolivar pressed forward, and on the 6th of August defeated Canterac on the plains of Junin, after which he returned to Lima, leaving Sucre to follow the royalists in their retreat to Upper Peru,—an exploit which the latter executed with equal ability and success, gaining a decisive victory at Ayacucho, and thus completing the dispersion of the Spanish force. The possessions of the Spaniards in Peru were now confined to the castles of Callao, which Rodil maintained for upwards of a year, in spite of all the means that could be employed for their reduction. In June 1825 Bolivar visited Upper Peru, which having detached itself from the government of Buenos Ayres, was formed into a separate state, called Bolivia, in honour of the liberator. The first congress of the new republic assembled in August 1825, when Bolivar was declared perpetual protector, and requested to prepare for it a constitution of government.

We now come to that period in the liberator's career when his care was directed to the administration of the affairs of the freed provinces. He had been successful in raising those districts to the position of independent states, and now devoted himself to the framing of such laws as seemed to him most suitable to the inhabitants. His endeavours to satisfy his countrymen in this respect did not always meet with encouragement, and sometimes exposed him to slander. In December 1824 Bolivar convoked a constituent congress for the February following; but this body, taking into consideration the unsettled state of the country, thought it proper to invest him with dictatorial power for another year. A grant of a million dollars was offered him but declined, and the congress adjourned, leaving the dictator absolute governor of Peru. His project of a constitution for Bolivia was presented to the congress of that state on the 25th May 1826, accompanied with an address, in which he embodied his opinions respecting the form of government which he conceived most expedient for the newly-established republics. This code, however, did not give satisfaction. Its most extraordinary feature consisted in the provision for lodging the executive authority in the hands of a president for life, without responsibility and with power to nominate his successor, a proposal which alarmed the friends of liberty, and excited lively apprehensions amongst the republicans of Buenos Ayres and Chili; whilst in Peru, Bolivar was accused of a design to unite into one state Colombia, Peru, and Bolivia, and to render himself perpetual dictator of the confederacy.

In the meanwhile the affairs of Colombia had taken a turn which demanded the presence of Bolivar in his own country. During his absence Santander had administered the government of the state ably and uprightly, and its independence had been recognized by other countries. But Paez, who commanded in Venezuela, having been accused of arbitrary conduct in the enrolment citizens of Caracas in the militia, refused obedienc summons of the senate, and placed himself in a open rebellion against the Government, being encouraged by a disaffected party in the northern departments who desired separation from the rest of the republic.

Accordingly, having intrusted the government to a council nominated by himself, with Santa-Cruz at its head, Bolivar set out from Lima in September 1826, and hastening to Bogota, arrived there on the 14th November. He immediately assumed the extraordinary powers which by the constitution the president was authorized to exercise in case of rebellion. After a short stay in the capital he pressed forward to stop the effusion of blood in Venezuela, where matters had gone much farther than he could have contemplated. On the 31st December he reached Puerto Cabello, and the following day he issued a decree offering a general amnesty. He had then a friendly meeting with Paez and soon after entered Caracas, where he fixed his headquarters, in order to check the northern departments, which had been the principal theatre of the disturbances. In the meanwhile Bolivar and Santander were re-elected to the respective offices of president and vice-president, and by law they should have qualified as such in January 1827. In February, however, Bolivar formally resigned the presidency of the republic, at the same time expressing a determination to refute the imputations of ambition which had been so freely cast upon him, by retiring into private life, and spending the remainder of his days on his patrimonial estate. Santander combated this proposal, urging him to resume his station as constitutional president, and declaring his own conviction that the troubles and agitations of the country could only be appeased by the authority and personal influence of the liberator himself. This view being confirmed by a resolution of congress, although it was not a unanimous one, Bolivar decided to resume his functions, and he repaired to Bogota to take the oaths. Before his arrival, however, he issued simultaneously three separate decrees,—one granting a general amnesty, another convoking a national convention at Ocaña, and a third for establishing constitutional order throughout Colombia. His arrival was accelerated by the occurrence of events in Peru and the southern departments, which struck at the very foundation of his power. Not long after his departure from Lima, the Bolivian code had been adopted as the constitution of Peru, and Bolivar had been declared president for life on the 9th December 1826, the anniversary of the battle of Ayacucho. At this time the Colombian auxiliary army was cantoned in Peru, and the third division, stationed at Lima, consisting of veteran troops under Lara and Sands, became distrustful of Bolivar's designs on the freedom of the republic. Accordingly, in about six weeks after the adoption of Bolivar's new constitution, a counter-revolution in the government of Peru was effected by this body of dissatisfied veterans, and the Peruvians, availing themselves of the opportunity, abjured the Bolivian code, deposed the council appointed by the liberator, and proceeded to organize a provisional government for themselves. After this bloodless revolution the third division embarked at Callao on the 17th March 1827, and landed in the southern department of Colombia in the following month. Intelligence of these events reached Bolivar while in the north of Colombia, and he lost no time in preparing to march against the refractory troops, who formerly had placed such implicit confidence in him. But he was spared the necessity of coming to blows, for the leaders, finding the government in the hands of the national executive, had peaceably submitted to General Ovando. In the meanwhile Bolivar had accepted the presidency, and resumed the functions belonging to his

did not conceal their conviction that a stronger and more permanent form of government was essential to the public welfare. The latter view seems to have prevailed. In virtue of a decree, dated Bogota, the 27th August 1828, Bolivar assumed the supreme power in Colombia, and continued to exercise it until his death, which took place at San Pedro, near Santa Martha, on the 17th December 1830.

In the career of this remarkable man, which was often embittered and was perhaps shortened by the suspicions and slanders of his colleagues in the work of liberation, certain circumstances, apparently well established, stand out, which deserve particular mention. He expended nine-tenths of a splendid patrimony in the service of his country; and although he had for a considerable period unlimited control over the revenues of three countries,—Colombia, Peru, and Bolivia,—he died without a shilling of the public money in his possession. He conquered the independence of three states, and called forth a spirit in the southern portion of the New World which can never be extinguished. He purified the administration of justice; he encouraged the arts and sciences; he fostered national interests; and he induced other countries to recognize that independence which was in a great measure the fruit of his own exertions. Bolivar's remains were removed in 1842 to Caracas, where a monument was erected to his memory; and in 1858 the Peruvians followed the example by erecting an equestrian statue of the liberator in Lima.

BOLIVIA

Plate XVII. THIS name was given in honour of Bolivar (see last article) to a state in South America, formed in 1825 from the provinces of Upper Peru which formerly constituted part of the vice-royalty of Buenos Ayres. The bulk of the country extends from 10° to 23° S. lat., and from 58° to 71° W. long., and it is bounded on the N. by Peru and Brazil, on the E. by Brazil and Paraguay, on the S. by the Argentine Republic and Chili, and on the W. by the Pacific Ocean and Peru. The greater part of Bolivia is a mountainous and elevated country, more particularly at its western and central parts; but towards the east it becomes much less so, and at length terminates in extensive plains, which are bounded on the east by Brazil. From the Pacific coast the southern boundary of Bolivia runs along the 24th parallel of latitude (the limit decided by treaty with Chili in August 1866), to as far as the crest of the Andes; turning S. it follows the line of the mountains to 26° S. lat., in which parallel it crosses the plateau to the inner Cordillera, along which it lies N.N.E. to the 22d parallel. This line of latitude forms the boundary of territory which is certainly Bolivian, as far as the River Paraguay; but Bolivia, in common with the Argentine Republic and Paraguay, has claims on the unexplored territory of the Gran Chaco, which lies south of this line, and between the rivers Pilcomayo and Paraguay. From 22° on the River Paraguay, the frontier with Brazil was decided, by treaty of March 1867, to be a line following that river northward to the Bahia Negra in 20° 11′, along the Negra to its termination, and thence through the midst of the lagoons of Caceres, Mandioré, Gaiba, and Uberaba (lying immediately west of the Paraguay River), to Corixa Grande; thence in a straight line to Boa Vista and the source of the Verde; down that river to the Guapore, and along the latter to where the Beni joins it in 10° 20′ S.; thence in a straight line towards the source of the River Javary (in 7° S.) The present Government of Bolivia appears inclined, however, to repudiate this treaty, and to return to the older frontier, which included the tributaries of the Amazons as far as 6° 28′ S. On the Peruvian or western frontier the boundary follows a more or less northerly direction from the mouth of the River Loa in Atacama, along the Cordillera, crossing Lake Titicaca, and passing north thence to the line running from the Beni to the Javary.

Boundaries and divisions.

Before the formation of the republic, Bolivia, or the former province of Charcas, consisted of four great districts or "intendencias," which were under the rule of the viceroy of Rio de la Plata. These were—

1. Santa Cruz, formed of the districts of its bishopric—Mojos, Chiquitos, Santa Cruz, Valle Grande, Misque, and the special jurisdiction of its capital Cochabamba;
2. La Paz, consisting of the dioceses of its bishopric;
3. Potosi, comprising Tarija, Chichas, Lipez, Atacama, Porco, and Chayanta;
4. The province of La Plata, which embraced all remaining portions of the archbishopric.

At the present time the republic is divided politically into departments, provinces, and cantons. The departments, which are named La Paz de Ayacucho, Cochabamba, Potosí, Chuquisaca, Oruro, Santa Cruz de la Sierra, Tarija, Beni, and Atacama, have each one or two capital towns; the provinces and cantons have also each its chief place. Each department has a governor, who stands in direct communication with the Government; the subdivisions have their corregidors and alcaldes, who are subject to the governor.

The westerly departments of La Paz, Oruro, and Potosi are situated in the highest regions of the plateau of Bolivia, and are more valuable on account of their mineral riches than for their vegetable products, of which a coarse grass is characteristic. The first consists of a series of high ranges and deep valleys, in which the climate and production vary with the elevation; the second lies also in the high table-land or Puna region; both are rich in veins of gold, silver, and tin, but the mining of these has not yet been fully developed. The third, Potosi, belongs entirely to the highest regions of Bolivia, and is bare and dry, with a cold and rude but healthy climate; this is the greatest mining region of the country.

The central departments of Cochabamba, Chuquisaca, and Tarija lie partly on the high plateau, partly on the lower slopes and plains eastward, and pass thus through the whole series of changing climates and zones of production, from the bare high land to the tropical regions of the low lands. The first is eminently the granary of Bolivia and southern Peru, excelling in the cultivation of wheat; the industries of woollen and cotton manufactures are also most highly developed in the department, but its mines are not worked. Chuquisaca, of which only a third part lies in the high land, is also a vegetable growing region, in which wheat, barley, rice, peas, vines, and all sorts of vegetables are cultivated; cattle and horses are also numerous. The forests of this department and of Tarija, which slope down to the wooded and pastoral plains of the tributaries of the Paraguay, afford many species of valuable timber.

The departments of Beni (or Veni) and Santa Cruz de la Sierra lie altogether in the low lands of the east, stretching to the Rio Maderia and the Paraguay. The former is as yet little explored, but is a land of tropical forests, rivers, and swamps, with an unhealthy climate. Santa Cruz is also characterized by a hot, damp atmosphere, but produces garden and field fruits in astonishing richness,—coffee, cocoa, vanilla, sugar-cane, maize, and cotton. The forests of both of these departments afford an infinity of valuable

timber trees, and in the latter there is much pasture land well fitted for cattle breeding.

The department of Atacama, which belongs geographically either to Peru or Chili, forms the only part of Bolivia which comes into contact with the ocean, and is situated between the Andes and the Pacific coast. It is almost entirely desert and sterile, has many volcanoes, and is characterized by rapid changes of temperature; it is almost destitute of population, and is only inhabited in those parts of the coast in which valuable guano deposits are found, or where the nitrate deposits and silver mines in the interior are worked. Near its northern limit is situated the small port of Cobija, the only avenue by which foreign articles of commerce can enter the Bolivian Republic without the payment of transit duties. It has obtained peculiar and valuable privileges as an encouragement to the introduction of merchandise by this route, in preference to the more convenient routes by the Puertos Intermedios, belonging to the Republic of Peru. But the arid nature of the surrounding country, and the great scarcity of water, must greatly retard its advancement, since not only are the inhabitants scantily supplied with this necessary of life, but the mules employed in transporting goods into the interior are exposed to great hardships.

Mountains. Western Bolivia is the highest and most mountainous country of the two Americas. Five separate systems of mountains, curving from Peru in the north-west and passing south into Chili, may be distinguished as forming its high land. Nearest the Pacific is the range of the outlying *coast mountains*, which does not exceed 5000 feet in altitude. The range of the true *Andes* rises farther inland, forming part of the vast chain which extends along the whole of America; in Bolivia it attains an average height of 15,000 feet, and has a general width of 20 miles, having its highest known point here in the volcano of Sahama, 23,000 feet in elevation. Next follows the central system of the *Cordillera Real*, also named the eastern Cordillera, presenting a succession of sharp, rugged peaks, reaching up into the region of eternal ice and snow, higher generally than the Andes, but less massive: the peaks of Illimani (21,300 feet) and Sorata (24,800 feet) are its culminating points. Between the Andes and the Cordillera Real there are various *Serrania* or isolated groups of mountains, and single cerros of less altitude, rising from the enclosed plateau to 17,000 feet in some instances. The last system is that of the numerous minor Cordilleras, which run south-eastward from the Cordillera Real into the lowlands of eastern Bolivia, of which the most important is that of Cochabamba, stretching out to 62° 40′ E. long. The elevation of the snow line in the highlands of Bolivia appears to vary between 16,000 and 18,000 feet, modified in many cases by the aspect of the mountains and the nature of the country surrounding them, being raised where heat is powerfully reflected from the surface of the bare high plains, or lowered where the mountains are exposed to cold southerly winds. Volcanoes are frequent in the Andes and coast ranges; those of Sahama and Isluga, with Tua, Olca, and Ollagua farther south, are constantly smoking.

These mountain systems divide Bolivia into a high region, containing many very elevated plains stretching between the enclosing heights of the west, and a low land forming the eastern side of the country, beneath the mountains, and at a comparatively small elevation above the sea. The high plains or basins of the plateau enclose a continental water system, from which there is no outlet to the ocean, the rivers terminating in lakes, of which Lake Titicaca is the chief, or in swamps, or in vast dried up salt fields,—rapid evaporation disposing of and balancing the supply of water flowing to these by the mountain streams.

Lakes. The valley or plateau which is occupied by the Lake of Titicaca and the Rio Desaguadero forms the most elevated table-land in the globe, with the exception of that of Thibet, which presents only mountain pastures, covered with sheep; while this table-land of the New World presents towns and populous cities, affords support to numerous herds of cattle, *llamas*, *guanacos*, and sheep, and is covered with harvests of maize, rye, barley, and wheat, at an elevation which has nothing to equal it in any other part of the world. The Lake of Titicaca or Chuquito, which occupies its northern extremity, is 12,600 feet above the level of the sea, and its extent is equal to fourteen times that of the Lake of Geneva, or 3220 square miles, the greatest depth being upwards of 700 feet. It is surrounded by numerous towns and villages, and a rich and fertile country, and contains several islands, the largest of which is called Titicaca, and was long held in great veneration by the Peruvian Indians, in consequence of its having been the place whence Manco Capac and his consort Manco Oello Huaco, the great founders of the empire of the Incas, issued, to spread civilization, industry, and good government among the surrounding nations. The Lake of Titicaca is very irregular in its form. It admits of extensive navigation for small vessels, though not unattended with danger, as it is subject to sudden storms and violent gusts of wind from the neighbouring mountains. This lake communicates with the smaller Lake of Pansa, or of the "Pampa Aullagas," situated at the southern extremity of the valley, by means of the Rio Desaguadero, which flows out of the Lake of Titicaca, and has a breadth of from 80 to 100 yards. This river and lake form part of the western boundaries between the Republics of Bolivia and Peru. Over the river was formed, in the time of the Incas, a suspension bridge, composed of cables and cords made of the grass and rushes which grow on its borders; and the work was constantly renewed from time to time, to obviate the effects of decay, as it constituted the only line of communication between the opposite sides of the valley. These lakes, with the Desaguadero, form the only receptacles for the water of those rivers and streams which descend from the surrounding mountains and enter this extensive plain, which has no visible outlet whereby its contents can escape otherwise than by evaporation.

Those rivers which take their rise from the western declivity of the Andes, and flow into the Pacific, are so inconsiderable in magnitude, and so short in their course, as scarcely to merit observation, and are only useful in supplying the means of a partial irrigation to the arid plains which separate these mountains from the Pacific. But those numerous rivers taking their origin on the eastern declivity of the Cordillera Real, which is the main waterparting of Bolivia, present a very different aspect, and are of much greater importance, since they communicate with large navigable rivers, which terminate in the Atlantic Ocean. Rivers.

rivers flowing to the great mediterranean navigation system of the Amazons in the north, or to the Rio de la Plata. More than forty years ago the importance of opening up a river highway from eastern Bolivia to the Rio Paraguay had impressed itself strongly on the Government, and large grants and privileges were offered in encouragement of this object, the rivers Otuquis, Tucabaca, and Latirequiqui, flowing to the Paraguay about the 20th parallel, being looked to as probably affording the desired navigable way. As yet, however, though this plan has been frequently revived, no definite progress has been made in this direction. An expedition sent down the Rio Pilcomayo in 1844 reported it innavigable. On the side of the Amazons, the rapids of the River Madeira, 18 in number, and extending over a distance of 230 miles, form a great natural barrier; to overcome this and to connect the navigable upper tributaries in Bolivia with the navigation of the lower Madeira, a company was recently formed for the construction of a railroad along the interrupted portion of the course of the Madeira: this scheme also is for the present in abeyance. It seems probable, however, that the recent opening of regular navigation on the Rio Vermejo from the Paraguay to the upper Argentine province of Jujuy on the southern frontier of Bolivia may to some extent afford an outlet, and tend to develop the resources of that part of the country.

Climate and vegetation.

Bolivia lies, as has been noticed, for the most part within the tropical zone; but from its peculiar formation, its climate and productions are dependent rather upon the elevation of different parts of the land than upon its geographical situation. In descending from the highest region of snow and ice to the low plains of rich tropical vegetation several zones or stages are distinguished. The name *Puna brava* is given to the uppermost mountain regions which rise above 12,500 feet to the snow limit: these are scarcely inhabited by man, and are characterized by mosses and hardier grasses,—the animal kingdom being represented by the vicuña, guanaco, llama, alpaca, viscacha, chinchilla, besides the condor and other birds of prey. The region between an elevation of 11,000 feet and the lower Puna brava is termed the *Puna*; less cold than the former, it is suited for the growth of potatoes, barley, and rush-like grasses, upon which sheep, llamas, vicuñas, &c., may feed. This division embraces the whole of the high plains of Bolivia, which are but scantily peopled or cultivated. Several species of cactus are found in these elevated regions, and especially the *Cactus peruvianus*, which sometimes grows to a height of from 20 to 30 or even 40 feet, and is serviceable for many purposes. Under the general name *Cabezera de Valle* are grouped the heads of the valleys descending to the lower lands, between 9500 and 11,000 feet in elevation, where the climate is temperate. These cultivable districts produce wheat, maize, and the ordinary vegetables. The *Valle* or *Medio Yunga* is the general name of the deeper portions of the valleys, between 9500 and 5000 feet, with warm climate, affording field and garden fruits in abundance. The *Yunga*, lastly, is the low tropical region, comprising all beneath 5000 feet, and producing all kinds of tropical fruits and vegetation.

In the punas the air is always dry and perceptibly cold, though the temperature may rise high in the sun, and cold, cutting blasts of air from the mountains are of frequent occurrence. In the Valle and upper Yunga a perpetual spring seems to reign, and night frosts are rare. The western side of the Andes is completely rainless, all moisture-bearing clouds rolling up from the ocean being quickly evaporated, or condensed in the higher mountain regions in snow or hail; but the whole of the remaining eastern region of Bolivia has a rainfall. In the lowlands this is irregular in season; but in the upper regions of the Puna and the Cabezera de Valle, a rainy season generally begins in the middle of November and concludes in the beginning of March, often accompanied by furious thunderstorms, with hail and snow in the higher regions. The climate of Potosi, at an elevation of 13,300 to 13,600 feet, is so various that in one day it frequently exhibits the vicissitudes of the four seasons of the year. Thus, during the night and the early part of the morning it is piercingly cold; in the forenoon it resembles our fine weather in March; in the afternoon the rays of the sun in so pure and attenuated an atmosphere are very powerful and scorchingly hot; while towards evening the air usually becomes mild and serene. Strangers on first arriving in these higher plains are usually affected with difficulty of breathing, owing to the extreme rarity of the atmosphere; they are likewise sufferers from dysentery, which, however, for the most part soon disappears, and in general the highlands are by no means unhealthy. Travellers in the higher regions are exposed to great danger and hardships owing to the storms which occasionally prevail, especially snow storms, which frequently produce the *surumpi*, or snow blindness, an affection which has proved fatal to some travellers. An infectious fever called "fiebre amarilla" sometimes breaks out in the Indian villages of the Puna, causing great loss of life; coughs and lung diseases are prevalent among the children in the punas, and do much injury among grown people in the Valle and Yungas. In descending through the eastern provinces towards the plains of Mojos and Chiquitos, all the gradations of climate are experienced down to that which characterizes the equinoctial regions of America, where intermittent "*terciana*" or cold fevers, dysenteries, and other diseases peculiar to warm climates prevail.

Anima[ls]

The animals which distinguish the more elevated parts of Bolivia are the *guanaco*, the *llama*, the *alpaca* (the first supposed to be the original from which the second and third varieties have been domesticated), and the *vicuña*. These animals, in their structure and habits, are all closely allied to the camel of Africa. Thus, an examination of the structure of the stomach shows that they are capable of existing during a considerable time without any supply of water, and in fact they are seldom seen to drink from the streams of their native mountains. The camel seems peculiarly well calculated to live in the arid and burning deserts of the Old World, and the form of its feet is singularly adapted for traversing rapidly these extensive plains; whilst, on the other hand, the guanaco and the llama have their feet so constructed as to enable them with facility to ascend and descend the abrupt declivities, and to traverse the rugged and uneven passes which abound in these mountains. They seem likewise to frequent particularly those parts of the Cordillera of the Andes which are the most dry and arid, and which are least clothed with forests and shrubbery. Thus, in the Cordillera which separates the Argentine Republic from Chili, the guanacos are found in great numbers on the summits and eastern declivities, which are exceedingly arid and bare when compared with the western or Chili side, where the Andes in their whole extent are clothed to a certain elevation with a broad belt of forest trees and evergreens, and where, at certain seasons of the year, there are heavy and continued rains. On this side guanacos are of comparatively rare occurrence. Their flesh is savoury when young, but not very palatable when full grown; their wool, however, is very valuable to the Indians, who manufacture it into hats and various kinds of woollen stuffs; and their skins, when tanned, are useful in making shoes and harness. The number of these animals in the country is estimated at not less than three millions; about a third part of them, the full-grown males, are employed as

beasts of burden, all the traffic of Bolivia being carried on by means of them.

The vicuña (*Camelus vicugna*) is a smaller animal than the guanaco or the llama, and only useful for its fleece. The wool is long and fine, and forms a valuable article of commerce; it is of a brownish colour, somewhat resembling that of a dried rose leaf; it has a soft, silky, and close texture, and is well adapted for the manufacture of hats and warm clothing. The vicuña very much resembles the llama and guanaco in its habits and dispositions, but cannot be usefully employed as a beast of burden. It usually frequents the highest parts of the mountains, is extremely timid, is gregarious, and runs very swiftly. The chinchilla (*Chinchilla lanigera*) is also an inhabitant of the mountainous parts of Bolivia. The skins, however, are of an inferior quality, although larger than those obtained from the northern parts of Chili; but still they form a very valuable article of commerce, on account of the great fineness and delicacy of their furs.

The sheep pasturing in the highlands of Bolivia are supposed to number about seven millions, and in the lower regions of the east horned cattle are very numerous. The eastern or more thickly-wooded parts of Bolivia are inhabited by a variety of wild animals, such as the jaguar and the tapir, which are more or less common in Brazil and the other parts of intertropical America of inconsiderable elevation.

Geology. The geological structure of the colossal mountains situated in Bolivia has hitherto been very imperfectly examined. We learn from Humboldt, however, that the metalliferous mountains near Potosi are principally composed of trachytic porphyries; and Mr Pentland discovered trachyte also in the mountain of Pichu, one of the most elevated of the western Cordillera. In the same chain there likewise exist various volcanic mountains, some of which are in an active state. There is perhaps no part of the world which affords a more interesting field for the investigations of the geologist than Bolivia, not only on account of the great elevation which it attains, but also from the exhibitions of internal structure presented by volcanic agency and otherwise,—not to mention the aid afforded by such inquiries in the prosecution of mining enterprises.

Minerals. The great variety, extent, and value of the mineral productions of the mountainous districts of Bolivia have given to this part of America an importance and celebrity which it would not otherwise have obtained, and have caused large and populous cities and towns to be built at elevations where the rigours of the climate and the deficient vegetation would otherwise have afforded very few inducements for fixing the abodes of industry. Mining is, however, at the present time in a ruinous state.

Gold is found in considerable quantities in the mountainous parts of Bolivia; but, owing to the expense of extracting the metal from the ore, the mines which produce it have not been worked to the extent of which they are capable. In these it is usually found in the form of grains or nodules, or intermixed with antimony, silver, and other substances, and is separated by reducing the whole to a fine powder, and by amalgamation with quicksilver. The mountain of Illimani is believed to contain great quantities of gold, in consequence of that metal having been found in a native state in considerable quantities in the lake of Illimani, situated at its base. In the 17th century, likewise, an Indian found here, at a short distance from the city of La Paz, a mass of native gold, which was said to have been detached from the mountain by the agency of lightning, and which, having been purchased for the sum of 11,269 dollars, was afterwards deposited in the cabinet of natural history at Madrid. But by far the greater part of the gold procured in Bolivia is obtained by means of the *lavaderos* or gold-washings, in the beds of rivulets, where it is found in the form of grains. The most productive of these are the celebrated lavaderos of Tipuani, consisting of streams descending from the snow-capped summits of the Cordillera of Ancuma, situated about sixty leagues to the north-east of the city of La Paz, in the province of Larecaja. The gold is found in the form of grains or *pepitas*, at the depth of 10 or 12 yards below the surface, embedded in a stratum of clay of several feet in thickness. The gold-washings at Tipuani were worked in the time of the Peruvian Incas, as is evinced by their tools, which are occasionally found embedded in the alluvial soil, and almost invariably in such situations as prove the most productive. The gold-washings and quartz veins of Choquecamata, in the province of Ayopaya in Cochabamba, are also famous, and their yield up to 1847 was valued at £8,000,000. Several districts of the departments of Potosi, Chuquisaca, Santa Cruz, and Tarija, are also rich in gold, but the greater part of the mines formerly worked have now been abandoned, or the known veins have not been explored.

Silver. Silver, however, has hitherto been the staple metallic production of Bolivia, and has given to it that celebrity which it has long possessed. In the rich mountains of Potosi alone, according to the records kept at Potosi of the *quintas* or royal duties from the year 1545 to the year 1800, no less than 823,950,509 dollars were coined during that period; and if the other produce of the mines be taken into account, it is estimated that not less than 1,647,901,018 dollars must have been obtained from this source alone during those 255 years.

The Cerro de Potosi, or argentiferous mountain of Potosi, has a somewhat conical form, resembling a colossal sugar-loaf; its base being about three leagues in circumference, and its summit 15,977 feet above the level of the sea, and 2697 above the level of the great square or *plaza* of the city of Potosi, which is situated at its base. At the foot of the Cerro is a smaller mountain called Huayna Potosi, or the Younger Potosi, likewise containing silver, but in less abundance than the other, and less accessible, from the numerous springs which there impede the operations of mining. The principal mountain has been worked as high up as within 125 feet of its summit. The labours of the miners have been principally confined to the upper half of the mountain, which has been perforated by numerous excavations, with at least 5000 openings of mines, the greater number of which are however abandoned. The upper part of the mountain is exhausted to a considerable extent of its valuable contents; but the lower part is still in a great measure untouched, as the springs are there more numerous, and the water accumulates in such quantities as materially to interrupt the further progress of the miners. The mines of Potosi, according to Humboldt, rank next in importance to those of Guanaxuato in Mexico. The existence of silver in this place was first accidentally discovered by an Indian in the year 1545, and ever since that time its mines have been worked. In 1858, twenty-two companies were working 46 silver mines and 4 tin shafts in the province of Potosi, and the yield in 1856 amounted to a value of nearly a million dollars.

are now abandoned; and those of the province of Arque in Cochabamba are not now regularly worked. The rich silver mines of Lípez also lie fallow, as do those of the department of Oruro. In 1870 great silver deposits were discovered at Caracoles, about 120 miles inland, in the desert province of Atacama, drawing thither a rush of miners from all parts of Chili and Peru.

Among the other mineral riches of Bolivia copper takes the next rank, and is also widely distributed. The province of Ingavi in La Paz possesses mines from which 15,000 to 20,000 cwts. of copper are annually taken. The departments of Potosí, Chuquisaca, Oruro, and Atacama are also rich in copper. Tin is mined to some extent in Potosí and Oruro, where it is found along with the silver. Lead is also frequently found in the neighbourhood of silver, as well as quicksilver. The methods hitherto employed for the reduction of the ores of this country are exceedingly imperfect and inefficient. More skill and capital are requisite to render them productive and remunerating. Coal and iron have been found in the departments of Chuquisaca, Oruro, and Beni, though the extent or value of these products is yet unknown. Precious stones, chiefly the hyacinth and opal, have been found in the department of Santa Cruz, and diamonds in Beni.

Very valuable beds of guano extend along the Pacific coast between 23° and 25° S., those of Mexillones being specially famous. Nitrate of soda also exists in great quantity in the deserts of Atacama, and is profitably worked.

The roads which form the means of communication between Bolivia and the surrounding countries, and between the various provinces of the republic, are in no respect sufficient for the important purposes which they are destined to serve. By inattention to the formation and preservation of roads, the Spaniards and their descendants have fallen greatly behind the ancient Peruvians, whose industry and civilization they affected to despise, and laboured hard to depreciate. The present route, for it can scarcely be designated by the name of road, from Potosí to Jujuy, the first city belonging to the Argentine Republic, is about 310 miles in length; and this place forms the point where a road commences for carriages and waggons as far as Buenos Ayres, an additional extent of land carriage of about 1617 geographical miles. The various routes from Bolivia to the coast of the Pacific, by the way of Cobija, by Tarapaca, and by Oruro to Tacna, can only be passed on mules or horseback; and travellers are sometimes exposed to great perils and hardships from exposure to the storms which occasionally prevail at such great elevations. The President Ballivian, however, while in office, did much to obviate these difficulties, and initiated a new era of things by the construction of a splendid highway, which leads from Sucre, and passing Santa Cruz, connects Mojos and Chiquitos and the fertile plains of the Beni and Madeira.
Although railroads are as yet unknown in the greater part
for Bolivia, and though the country presents the most
a begidable natural difficulties in the way of engineering,
line atning has been made in this direction. The only
one frotsent constructed in Bolivian territory is a short
Mexillonesthe bay of Autofagasta, south of that of
of soda workthe Pacific coast, in Atacama, to the nitrate
this line inlandSalar el Carmer; it is intended to extend
of Caracoles. the nitrate fields and to the silver mines
southern Peruvia also proposed to extend one of the
of Iquique to Oruro es, starting from near the point
main outlets of western olivia. At present one of the
from the port of Mollenvia is by the Peruvian railroad
Titicaca, completed in d Arequipa to Puno, on Lake
is connected with Bolivi Puno, its inland terminus,
Titicaca. am navigation across Lake

The productions furnished by Bolivia as articles of commerce are chiefly the precious metals, vicuña and alpaca wool, guano, nitrate of soda, leather, coffee, cacao, and chinchona bark; but from the fact that no direct commercial intercourse has ever existed with the outer world, these products are frequently ascribed to the countries through which they must pass. Thus the metals and wools of Bolivia are looked upon as Peruvian, and the cinchona bark and gums passing out eastward are credited to Brazil or the Argentine Republic. The rude and simple fabrics manufactured by the Peruvian Indians are usually appropriated to their own domestic uses; while the valuable vegetable productions, and the herds of cattle and mules which are reared in the eastern parts of the republic, have hitherto scarcely been sufficient for the supply of the inhabitants of those populous mining districts that are principally dependent on them for subsistence. Products and trade

Before the war of independence a very extensive traffic was maintained between the upper provinces of Peru (or Bolivia) and the provinces of the Rio de la Plata for supplies of cattle and mules. These were reared in great numbers in all the interior Argentine provinces expressly for the use of those countries, and were first sent by easy journeys to the luxuriant pastures of Salta and Jujuy, where they were carefully fed and tended during the winter, previous to their being conveyed to their final destination in Bolivia and Peru. Some idea may be formed of the extent of this traffic from the statement that, besides all those furnished by the other Argentine provinces, the province of Salta alone supplied annually to Upper and Lower Peru from 60,000 to 80,000 mules, on all of which they realized considerable profits, the prices being proportioned to the distance to which they were conveyed. The customs derived from the import of cattle from the Argentine Republic still form an important source of revenue. The trade is now in a great degree diverted from the Argentine provinces to the ports of the Pacific called the Puertos Intermedios. Tacna and Arequipa, with their respective ports, have now become the principal channels through which Bolivia receives the produce and manufactures of other countries, the Bolivian port of Cobija being of little value, owing to the difficulties of transport from it by mules and llamas across the desert track and the mountains. There are no certain returns of the value of the trade of Bolivia; the importation by Tacna and Arica is valued at 5 or 6 millions of dollars, that of Cobija at $1\frac{1}{2}$ to 2 millions. A new and very important channel of communication for commerce will be opened between Bolivia and the Atlantic, whenever commercial enterprise and increasing civilization shall have established steam navigation on the Rio de la Plata and its tributary streams, or from the mouth of the Amazons to its distant tributaries the Beni and the Mamore.

The population of Bolivia consists of a mixture of various races, chiefly of the Spaniards with the Indian natives. A third of their number live in towns or "villas," the rest in smaller villages, or in the open camp. Besides the native Indians there are in the country some descendants of African negro slaves, and not a few Guaranis, who came over from the regions east of the Paraguay, and settling in the plains, have increased in numbers. The Indian population may be considered as the civilized, the half civilized, and the wild. To the first class belong the Quichua and Aymara, or the Inca Indians, who are by far the most numerous, who have come most closely into contact with the Spanish invaders, and who occupy chiefly the highlands of the west. The Indians of Mojos and Chiquitos may be considered as representing the half-civilized class,—retaining part of the civilization introduced among them in the 17th century by the Jesuits. The nomadic or wild Indians of the eastern lowlands in Population.

Bolivia belong to the following tribes:—The *Sirionos*, who inhabit the banks of the Rio Grande or Guapay, and of the Rio Pirai; the *Hichilos*, who occupy the pampas north of San Carlos in the department of Beni; the *Penoquiquias*, living in the upper or southern districts of the River Itonama or San Miguel; the *Guarañocas*, inhabiting the western portion of the space between the rivers Tucabaca and Latiriquique; the *Potororos* in the north-west of the same district; and the *Chiriguanos*, occupying the country along the north of the upper Pilcomayo below the confluence of the Pilaya. To these may be added the *Tobas*, who though they generally occupy the lower basin of the Rio Vermejo in the Argentine portion of the Chaco, occasionally make raids into the departments of Tarija and Chuquisaca, plundering and destroying the villages, and carrying off women and cattle. The Quichua and Aymara have no relations or sympathies with the Indians of the plains, who in their turn hold the civilized Indians in great contempt. These descendants of the Peruvians under the empire of the Incas are still numerous, notwithstanding the many causes which have tended to diminish their numbers, and form a distinct race, preserving the language and manners of their ancestors, their habits having been only somewhat modified by the circumstances in which they have been placed since they came under the dominion of the Spaniards. The Quichuas are mild in character, apparently subdued and apathetic,—qualities which are but the natural result of the state of subjection and debasement in which they were long held by their conquerors; they are, however, robust and muscular, and capable of great endurance, though little inclined to labour; their customs are rude and simple, their mode of living poor in the extreme. The Aymara are perhaps more mobile in character, but in other respects similar. Both are cultivators of the land according to their rude notions of husbandry; vegetables, especially maize and potatoes, form the staple of their food, and they indulge freely in their favourite *chicha*, an intoxicating liquor prepared from maize; many are employed as drivers of llama trains, or are breeders of the llama, sheep, or goats, which they possess in great numbers. Among the half-bred population of Bolivia, who stand in relation of numbers to the Inca Indians as about one to two, there are distinguished the *zambo*, or half-negro half-Indian, powerful in frame and intelligent, but unfaithful and cunning; the *mulatto*, or offspring of the Spaniard and negro; and the *cholo*, the descendant of the alliances of the Spaniards with the Inca Indians. The last generally resemble their fathers in character, and occupy themselves chiefly in mining. It is to the Cholos that Bolivia owes its political independence.

The population of Bolivia has greatly increased since the year of independence, 1825, when the whole number did not exceed 979,000; in 1831 it exceeded 1,000,000; at the census of 1846 it had risen to 1,380,000. The following table shows the population of each department, as given by Ondarza in 1858. This is the most recent detailed statement of the population of Bolivia, but an estimate of the population of the ecclesiastical divisions of the country for 1874 is appended to it; the provinces into which each department is divided are also named, on the authority of Herr Reck:—

Departments.	Provinces.	Population, 1858.
La Paz	La Paz, Omasuyos, Ingavi, Sicasica, Muñecas, Yungas, Larecaja, Inquisivi	475,322
	Carry forward,	475,322
	Brought forward,	475,322
Cochabamba	Cochabamba, Cliza, Tapacarí, Mizque, Arque, Ayopaya	349,892
Potosi	Potosí, Porco, Chayanta, Chichas, Lipez	281,229
Chuquisaca	Yamparaes, Tomina-azero, Cinti	223,668
Santa Cruz de la Sierra.	Santa Cruz, Valle Grande, Chiquitos, Cordillera	153,164
Oruro	Oruro, París or Poópo, Carangas	110,931
Tarija	Tarija, Salinas, Concepcion	88,900
Beni	Mojos, Caupolican or Apolobamba, Juracarés	53,973
Atacama ...	Upper and Lower Deserts	5,273
		1,742,352
	Wild Indians	245,000
	Total..............	1,987,352

The *Archbishopric of La Plata*, including the departments of Potosí, Chuquisaca, Oruro, Tarija, and Atacama, contained in 1874 706,989 inhabitants; the *Bishopric of La Paz*, the department of La Paz, 519,465; the *Bishopric of Santa Cruz*, the department of Santa Cruz, 205,131; and the *Bishopric of Cochabamba*, the department of Cochabamba, 379,783,—total, 1,811,368. Decrees of 1866 and 1867 ordered the formation of two new departments, viz., *Melgarejo*, to be formed of part of the existing department of Cochabamba, and including the town of Tarata, and *Mexillones*, on the coast.

The populations of the chief towns, in 1858, were as follows:—La Paz, 76,372; Cochabamba, 40,678; Chuquisaca or Sucre, 23,979; Potosí, 22,580; Santa Cruz, 9780; Oruro (the seat of Government since 1869), 7980; Tarija, 5680; Trinidad, 4170; Cobija, 2380. Among the small number of foreigners in the country, Italians, Spaniards, and French are in a majority.

Area. The area of Bolivia, hitherto very uncertain, on account of the indefinite state of the frontier on the east and south, has been calculated at Gotha, on the basis of the recent determination of the boundary with Brazil, at 536,200 English square miles, or about ten times the extent of England.

The constitution given to the country by Bolivar, which, in the frequent revolutions of later times has often been modified and altered, and sometimes set aside altogether, is founded on the strictest principles of justice, in as far as regards the civil rights and privileges of the community; but in other respects, and particularly in reference to the supreme executive authority, its provisions savour strongly of a monarchical spirit. The supreme authority is vested in a *presidente vitalicio*, or president for life, with the power of naming his successor. It guarantees to the Bolivians civil liberty, security of persons and property, and equality of rights; the free exercise and communication of thoughts and opinions, either by the press or otherwise; liberty to remain or leave the territory of the republic with their property, at their pleasure, but without prejudice to others; equality in the imposition of taxes and contributions, from the payment of which none can be exempted; and the abolition of all hereditary employments, privileges, and entails. No profession, trade, or employment can be prohibited, unless repugnant to public feeling, or injurious to the health and security of the community; and every inventor is secured in the benefits of his discovery. No one can be arrested without previous information of the alleged fact of delinquency, unless when taken *flagranti delicto*. All trials and judgments are public; and in criminal cases none can be imprisoned more than forty-eight hours without having presented to him the charges preferred against him, and being delivered over to the proper tribunal or judge.

Government.

By this constitution all legitimate power emanates directly from the people, and is in the first instance exercised by all who can justly claim the privilege of citizens. Of these every ten nominate an elector, who exercises his delegated authority for a period of four years. At the commencement of each year all the electors assemble in the capitals of their respective provinces, and regulate their proceedings and the exercise of their various functions by a plurality of votes. They elect the members of the three legislative chambers, the number of each amounting to thirty; those for the chamber of tribunes being nominated for four years, and renewed by moieties every two years; those for the senate for eight years, and renewed by moieties every four years; and those for the chamber of censors being nominated for life.

The executive government consists of a president, vice-president, and three secretaries of state. The president of the republic is named for the first time by a majority of the collective legislature, and retains the dignity during life, with the power of naming his successor. He is the chief of the administration of the state, and is not responsible for the acts of his administration. The constitutional privileges of the president are the most limited that have been intrusted to the supreme chief of any nation. They extend only to the nomination of the officers of the revenue, of peace, and of war, and the command of the army. The administration belongs wholly to the ministry, which is responsible to the senate, and is subject to the jealous vigilance of the legislators, magistrates, judges, and citizens. The judicial department enjoys the most perfect independence, the members composing it being proposed by the people, and chosen by the legislature. Slavery in every form has long been abolished, and the exercise of religion is free from all restraints. The armed force is composed of the regular army, amounting to about 3000 officers and men, to garrison and defend the frontiers; of the national militia to preserve internal order; of the preventive service to protect the revenue; and of a navy when circumstances may require its formation.

Revenue.

The financial budget of Bolivia for 1873–74 was as follows, the amount being given in Bolivian dollars of the value of about 3s. 3d. sterling:—

RECEIPTS—

Customs { Arica	405,000
Customs { Cobija	250,000
Export of Silver	193,676
Sale of Guano	300,000
Stamps	27,628
Cattle Customs (Argentine Republic)	20,880
English Loan	650,000
Indian Tribute	686,307
Departments	396,423
	2,929,914

EXPENDITURE....4,505,504

Public debt 1873 = 16,428,329 bolivianos, including £1,700,000 sterling of the loan for railways.

The early history of that part of the empire of the Incas which now forms the Republic of Bolivia is so intimately connected with that of Peru, that the consideration of it may with propriety be deferred until we come to treat of that country, in which Cuzco, the capital of the Incas, is situated. Attention will therefore at present be directed chiefly to that period of its history which is more recent, and which has so materially influenced its present condition.

The Peruvians, ever since the conquest of their country by the Spaniards in the 16th century, have been subjected to a system of tyranny and oppression which has few parallels in the history of the universe. They were treated little better than beasts of burden. By their toil the gold and silver were obtained from the mines, the lands were cultivated, the flocks and herds were attended to, and all the domestic and menial offices performed. Yet the fruits of their labour, especially that of mining, which was attended with numerous privations, and often with great loss of life, were altogether devoted to enriching their oppressors.

One of their principal grievances was the *mita*, a compulsory kind of personal labour, either in the working of the mines or in the cultivation of the fields, exacted from the Indians generally for the space of one year. The proprietors of mines and land to be worked or cultivated were privileged to claim as their undoubted right the personal services of the Indian population of the district surrounding that in which their property was situated. By the regulations of the *mita* a proportional number of the Indians of the district were annually chosen by lot for the purposes required; and some idea may be formed of the effects of such a regulation from the fact that 1400 mines were registered in Peru alone, and that every mine which remained unworked a year and a day became the property of the first claimant. So much was the labour of the mines dreaded by those persons on whom the lot fell, that they considered it as equivalent to a sentence of death, and made all their arrangements accordingly, carrying with them their wives and families to their new and dreaded place of abode. An estimate may be formed of the extent of this evil from 12,000 Indians having been annually required by the *mita* of Potosi alone; and it is calculated that, in the mines of Peru, no less than 8,285,000 Indians have perished in this manner. Besides the *mita* for the service of the mines, the Indians were also compelled to labour for their superiors on their cultivated estates, their *estancias* or grazing farms, and also in their *obrages* or manufactories.

The tribute exacted by the Government from every Indian between the age of eighteen and fifty-five was a capitation tax of 8 dollars. This was levied with the greatest rigour, and the official persons charged with its collection frequently committed great injustice in doing so,—obliging the Indians to commence these payments at fifteen, and continue them until seventy years of age, and putting the amount of tribute for the years before and after the legal period into their own pockets. In proof of

the extent to which this evil was carried, and of the rapacity of the Spanish Government, it may be stated that a law was enacted for the express purpose of augmenting the number of the people liable to pay tribute. By it the Indians were obliged to marry, the men at the age of fifteen, the women at thirteen. The governor of each province was responsible to the Government for the amount of the tribute, which was regulated by a census of the tributary Indians, taken every seven years; and in this many frauds were practised, the actual number being often underrated.

Besides all these, the Peruvian Indians were long subjected to another system of extortion no less grievous and unjust,—the law of *repartamiento.* This was originally established with the best intentions,—the governors or *corregidors* of the districts being intrusted with the charge of supplying the inhabitants under their care with such articles as they might require at a fair and equitable price. But the law, which had so plausible an origin, was shamefully abused; and it was made compulsory on the Indian population to purchase worthless articles at an extravagant price.

The constant and extensive operation of these demoralizing practices, although more immediately affecting the aboriginal population, could not fail to produce the most pernicious effects on the Creoles or descendants of the Spaniards; but, in addition to these causes of debasement, the latter were subjected to numerous unjust and oppressive laws, all tending to paralyze their advancement.

The raising of those vegetable products which form the principal objects of culture in Spain, as articles of commerce, was strictly prohibited to the South Americans, however favourable the soil and climate of their native country might be for the production of them. No kind of manufacture of cloth or articles of clothing was permitted which could interfere with the commerce of Old Spain, excepting only the coarse fabrics manufactured and worn by the Indians. Even the valuable mines of mercury and iron found in South America were, in a great measure, hermetically sealed by prohibitory decrees, lest they might interfere with the traffic carried on by Spain in these articles. And, not only was the commerce of South America confined entirely to Spain and prohibited with other nations, under the severest penalties, but the colonies were not permitted to have any commerce with each other.

The grievances under which they suffered at length exceeded even the powers of endurance possessed by the pacific Indians, and gave rise to the insurrection of 1780–81, led by the Inca Tupac Amarú, who spread fire and sword against everything Spanish from Cuzco to Jujuy; twice the city of La Paz was besieged by a force of 20,000 Indians; and in the battle before that town Tupac Amarú was made prisoner and put to death in the most barbarous manner by the Spaniards. The insurrection was finally put down in 1782, and with it ended the last power of the Incas. The aboriginal population, having failed in their arduous undertaking, after the destruction of great numbers of their nation, and finding their chains now rivetted with double force, never again recovered their wonted energies. This accounts for the comparative indifference with which they viewed the rise and progress of the war of independence.

From the causes already stated, the war of independence was principally carried on, as regards Bolivia, by the resources of, and in concert with, the neighbouring provinces of the Rio de la Plata and Peru, all of which had equal cause to avenge themselves on their oppressors, but were placed in circumstances somewhat more fortunate for accomplishing their purpose. When the patriots of Buenos Ayres had succeeded in liberating from the dominion of Spain the interior provinces of the Rio de la Plata, they turned their arms against their enemies who held Upper Peru. An almost uninterrupted warfare followed, from July 1809 till August 1825, with alternate successes on the side of the Spanish or royalist and the South American or patriot forces,—the scene of action lying chiefly between the Argentine provinces of Salta and Jujuy and the shores of Lake Titicaca. The first movement of the war was the successful invasion of Upper Peru by the army of Buenos Ayres, under General Balcarce, which, after twice defeating the Spanish troops, was able to celebrate the first anniversary of independence near Lake Titicaca, in May 1811. Soon, however, the patriot army, owing to the dissolute conduct and negligence of its leaders, became disorganized, and was attacked and defeated, in June 1811, by the Spanish army under General Goyeneche, and driven back into Jujuy. Four years of warfare, in which victory was alternately with the Spaniards and the patriots, was terminated in 1815 by the total rout of the latter in a battle which took place between Potosi and Oruro. To this succeeded a revolt of the Indians of the southern provinces of Peru, and the object being the independence of the whole country, it was joined by numerous Creoles. This insurrection was, however, speedily put down by the royalists. In 1816 the Spanish general Laserna, having been appointed commander-in-chief of Upper Peru, made an attempt to invade the Argentine provinces, intending to march on Buenos Ayres, but he was completely foiled in this by the activity of the irregular *gaucho* troops of Salta and Jujuy, and was forced to retire. During this time and in the six succeeding years a guerilla warfare was maintained by the patriots of Upper Peru, who had taken refuge in the mountains, chiefly of the province of Yungas, and who frequently harassed the royalist troops. In June 1823 the expedition of General Santa Cruz, prepared with great zeal and activity at Lima, marched in two divisions upon Upper Peru, and in the following months of July and August the whole country between La Paz and Oruro was occupied by his forces; but later, the indecision and want of judgment displayed by Santa Cruz allowed a retreat to be made before a smaller royalist army, and a severe storm converted their retreat into a precipitate flight, only a remnant of the expedition again reaching Lima. In 1824, after the great battle of Ayacucho in Lower Peru, General Sucre, whose valour had contributed so much to the patriot success of that day, marched with a part of the victorious army into Upper Peru. On the news of the victory a universal rising of the patriots took place, and before Sucre had reached Oruro and Puno, in February 1825, La Paz was already in their possession, and the royalist garrisons of several towns had gone over to their side. The Spanish general Olañeta, with a diminished army of 2000 men, was confined to the province of Potosi, where he held out till March 1825, when he was mortally wounded in an action with some of his own revolted troops.

was summoned and formally installed at Chuquisaca on the 25th May 1826, to take into consideration the constitution prepared by Bolivar for the new republic. A favourable report was made to that body by a committee appointed to examine it, on which it was approved by the congress, and declared to be the constitution of the republic; and as such, it was sworn to by the people. General Sucre was chosen president for life, according to the constitution, but only accepted the appointment for the space of two years, and on the express condition that 2000 Colombian troops should be permitted to remain with him.

The independence of the country, so dearly bought, did not, however, secure for it a peaceful future. Repeated risings occurred, till in the end of 1827 General Sucre and his Colombian troops were driven from La Paz. A new congress was formed at Chuquisaca in April 1828, which modified the constitution given by Bolivar, and chose Marshal Santa Cruz for president; but only a year later a revolution, led by General Blanco, threw the country into disorder and for a time overturned the Government. Quiet being again restored in 1831, Santa Cruz promulgated the code of laws which bore his name, and brought the financial affairs of the country into some order; he also concluded a treaty of commerce with Peru, and for several years Bolivia remained in peace. In 1835, when a struggle for the chief power had made two factions in the neighbouring republic of Peru, Santa Cruz was induced to take a part in the contest; he marched into that country, and after defeating General Gamarra, the leader of one of the opposing parties, completed the pacification of Peru in the spring of 1836, named himself its protector, and had in view a confederation of the two countries. At this juncture the Government of Chili interfered actively, and espousing the cause of Gamarra, sent troops into Peru. Three years of fighting ensued, till in a battle at Jungay in June 1839 Santa Cruz was defeated and exiled, Gamarra became president of Peru, and General Velasco provisional chief in Bolivia. The Santa Cruz party, however, remained strong in Bolivia, and soon revolted successfully against the new head of the Government, ultimately installing General Ballivian in the chief power. Taking advantage of the disturbed condition of Bolivia, Gamarra made an attempt to annex the rich province of La Paz, invading it in August 1841 and besieging the capital; but in a battle with Ballivian his army was totally routed, and Gamarra himself was killed. The Bolivian general was now in turn to invade Peru, when Chili again interfered to prevent him. Ballivian remained in the presidency till 1848, when he retired to Valparaiso, and in the end of that year General Belzu, after leading a successful military revolution, took the chief power, and during his presidency endeavoured to promote agriculture, industry, and trade. General Jorge Cordova succeeded him, but had not been long in office when a new revolt in September 1857, originating with the garrison of Oruro, spread over the land, and compelled him to quit the country. His place was taken by Dr José Maria Linares, the originator of the revolution, who taking into his own hands all the powers of Government, and acting with the greatest severity, caused himself to be proclaimed dictator in March 1858. Fresh disturbances led to the deposition of Linares in 1861, when Dr Maria de Acha was chosen president. In 1862 a treaty of peace and commerce with the United States of North America was ratified, and in the following year a similar treaty was concluded with Belgium; but new causes of disagreement with Chili had arisen in the discovery of rich beds of guano on the eastern coast-land of the desert of Atacama, which threatened warfare, and were only set at rest by the treaty of August 1866, in which the 24th parallel of latitude was adopted as the boundary between the two republics. A new military revolution, led by Maria Melgarejo, broke out in 1865, and in February of that year the troops of President Acha were defeated in a battle near Potosi, when Melgarejo took the dominion of the country. After defeating two revolutions, in 1865 and 1866, the new president declared a political amnesty, and in 1869, after imposing a revised constitution on the country, he became its dictator till 1871.

Such, in brief, are the rapidly succeeding political changes and internal conflicts which have kept Bolivia far behind its neighbouring republics, and have prevented the development of its natural wealth. Notwithstanding these wars and revolutions which rent the country, Bolivia had maintained itself without foreign credit until the presidency of Melgarejo, when it was drawn into disastrous speculations and contracts which have compromised its credit and loaded the country with a heavy foreign debt.

President Morales was elected in 1871; since that time a civilian Government has succeeded to the military system, and attempts are being made to reform the disordered affairs of the republic.

A. Dessalines d'Orbigny, *Voyages dans l'Amerique méridionale, 1826–1833*, Paris, 1835, and *Descripcion geografica, historica, y estadistica de Bolivia*, Paris, 1845; Dalence, *Statistical Account of Bolivia*, 1846; H. A. Weddell, *Voyage dans le nord de la Bolivie*, Paris, 1853; Manoel José Cortés, *Ensayo sobre la Historia de Bolivia*, Sucre, 1861; David Forbes, *Report on the Geology of South America*, London, 1861; Hugo Reck, "Geographie und Statistik der Republik Bolivia," in *Geogr. Mittheilungen*, Gotha, 1865, 1866, 1867; Avelino Aramayo, *Projecto de una nueva via de communicacion entre Bolivia y el oceano Pacifico*, London, 1863,—also *Bolivia* (extracts from the last work, translated, with additions to 1874), London, 1874; José Domingo Cortés, *Bolivia*, Paris, 1875.

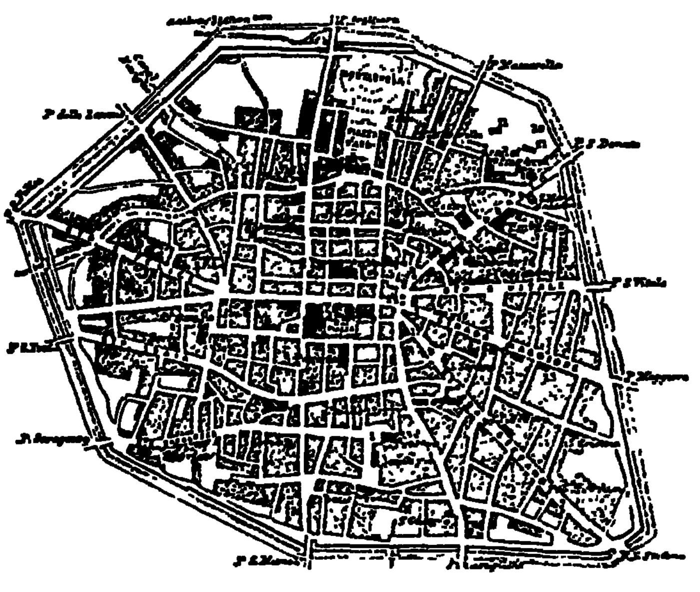
(K. J.)

BOLLANDIST FATHERS, The, the authors of the famous *Acta Sanctorum*. During the Roman Catholic revival in the end of the 16th and beginning of the 17th centuries a great number of martyrologies were published, and it occurred to a Jesuit father, Heribert Rosweyd, to collect all the various legends about the martyrs and saints of the church into one great standard martyrology, which he proposed should fill 18 vols. folio. Rosweyd died in 1629 without having been able to carry out his plan. His idea, however, was taken up by John Bolland, a Jesuit father of the Low Countries, who had settled in Antwerp. He began an extensive correspondence, writing to every one throughout Europe who he supposed was able to help him. The public libraries and the libraries of convents and churches were thoroughly examined for MSS. about saints and martyrs, and so much material was found that the original plan of the work was soon widened. The ground-plan of the undertaking was to form a huge calendar, giving the life and deeds of each saint under the heading of the day set apart by the church for his honour. In 1643 the first two volumes were published, containing the saints' days in January. Bolland died soon after the beginning of his labour, but not until he had seen the work fairly started; other deaths followed, but the work was prosecuted in accordance with the original plan, and went on prosperously until 1773, when the troubles which then overtook the Jesuits affected the Bollandists also. The little company struggled on, however, amid many difficulties until 1794, when they were dispersed; and the whole of the MS. collections were destroyed during the French invasion of the Netherlands. At this time 54 vols. had been published, bringing the work down to the 15th of October.

In 1837 three Jesuit fathers made proposals to continue the *Acta* according to the original plan, and in 1838 published a programme under the title *De prosecutione operis Bollandiani.* They made some progress with the undertaking, but their work is much inferior to the earlier *Acta.* The 54 vols. of the older Bollandists, along with 6 vols. of the continuation, were published at Paris and Rome in 1863-7.

BOLOGNA, a province of northern Italy, having an area of 1385 square miles. It consists in the north of a fertile plain, well watered by several tributaries of the Po, while the southern portion is occupied by the Apennines, which separate it from Tuscany. It is in a highly flourishing condition. The soil produces abundant crops of rice, barley, wheat, and pulse, besides hemp, flax, olives, grapes, figs, almonds, chestnuts, and other fruits. The culture of silk is largely prosecuted; and considerable numbers of cattle and swine are reared in the province.

BOLOGNA, the chief city of the above province and the see of an archbishop, is situated between the rivers Reno (*Rhenus*) and Savena, at the foot of the lower slopes of the Apennines, 399 feet above the level of the Adriatic, and 23 miles S.E. of Modena, on the main line of railway that runs across the north of Italy, in 44° 30′ N. lat. and 11° 21′ E. long The city is about 2 miles in length and 1½ in breadth, and is surrounded by a high brick wall with



Ground-Plan of Bologna.

twelve gates. The streets are clean and well paved, but are generally narrow and crooked; the houses are mostly three stories high with projecting roofs, and are very often surrounded with arcades. All the public as well as private buildings are constructed of brick. The Piazza Vittorio Emmanuele, formerly called Piazza Maggiore or del Gigante, is the principal square and has many fine edifices. In the centre is a fountain adorned with a colossal statue of Neptune by Giovanni da Bologna. The city contains no fewer than 130 churches, twenty convents, and six hospitals. Of the churches the largest is San Petronio, an unfinished but splendid structure dating from 1390, and dedicated to the patron saint of the city. The cathedral or S. Pietro, begun in 1605, is surpassed not only by it but by S. Dominico, S. Giacomo Maggiore, and various others. San Stefano is a curious collection of seven churches, with a good deal of antiquarian interest. (*Vide* Street's *Brick and Marble in the Middle Ages*, 1874.) Of the secular buildings the most important are the Palazzo Pubblico, founded in 1290, the Palazzo del Podestà, of slightly earlier date, the Palazzo della Mercanzia, or Chamber of Commerce, and a few of the residences of the great mediæval families. At the head of the educational institutions stands the university, which was once the most celebrated in Italy, but is now attended by only 400 or 500 students. The university library, which was at one time in the keeping of Cardinal Mezzofanti, numbers upwards of 140,000 volumes and 9000 MSS. The Accademia delle Belle Arte, situated in what was formerly the Jesuit's College, has a rich gallery of paintings, chiefly by native artists. There is a museum of antiquities in connection with the university, as well as a botanical garden, and an observatory; and the city possesses besides a scientific institute, a philharmonic lyceum, and various intellectual institutions, many of which are due to the liberality of Count Ferdinand Marsigli, in the 17th century. There are five theatres (the Teatro del Commune, erected in 1756 by Bibiena, on the site of the Palazzo Bentivoglio, being one of the largest in Italy), a casino, and a hall for playing the favourite game of ball. The leaning towers of Asinelli and Garisende are worthy of mention. They are situated quite near each other; the former, which is 272 feet in height, deviates 5 feet from the perpendicular, while the latter has a height of 138 feet and a divergence of 9. Bologna has long been famous for its Mortadelle sausages, its soap, and a kind of confection called *terra catù;* its manufactures also include crape, silk, glass, wax candles, paper, and musical instruments. The people have a very peculiar dialect. The city is the birthplace of Domenichino, Guido Reni, the Carraccis, Righini, Benedict XIV., and other famous men, and gave rise and name to the Bolognese school of painting. Population in 1871, 115,957.

Bologna is said to have been founded by an Etruscan king, and was originally called Felsina after his name. It was held for some time by the Boian Gauls, and on their expulsion became, in 189 B.C., a Roman colony under the name of Bononia. Its importance rapidly increased, but it does not appear much in history till the time of the civil wars. The terms of the second triumvirate were settled in 43 B.C. in an interview held between Octavius Antony and Lepidus on a neighbouring island. During the later empire the city was frequently an imperial residence, and in 410 A.D. it was still strong enough to resist the forces of Alaric. It afterwards passed under the power of the Lombards, and on their subjugation by Charlemagne it was united to his empire and made a free imperial city. In 962 it became an independent republic, which soon acquired an extensive commerce and a powerful military force. The Middle Ages form the period of its greatest celebrity and importance. In the Crusades the Bolognese took an active share; and after a long neutrality in the contest between the Ghibellines

styled in Italy), a celebrated sculptor, was born at Douay in 1524, and died at Florence in 1608. He went early to Italy, and studied at Florence, where his best works still remain. His two most celebrated productions are the single bronze figure of Mercury, poised on one foot, resting on the head of a zephyr, as if in the act of springing into the air (in the Florentine gallery), and the famous marble group of the Rape of the Sabines, which received this name, Lanzi informs us, after it was finished. It is now in the Loggia de Lanzi of the ducal piazza. Giovanni was also employed at Genoa, where he executed various excellent works, chiefly in bronze. All his pieces are characterized by great spirit and elegance.

BOLSENA, a town of Italy, in the province of Rome, and the district of Viterbo, 10 miles S. by E. of Orvieto. It is situated on the north shore of the lake of the same name (*Lago di Bolsena*), and probably occupies the site of the Roman city of Volsinii. The principal remains are the ruins of an amphitheatre and those of a temple, which is popularly called *il Tempio di Norzia* after the Etruscan goddess Norsia, and there are numerous other relics scattered throughout the city or built into the walls of its modern buildings. Volsinii was originally one of the most powerful of the Etruscan cities, and occupied a position among the hills; but after a series of struggles with the Romans, the Volsinians were finally subdued about 280 B.C., their city was razed to the ground, and themselves obliged to settle in a less defensible site in the plain. The only event of interest in the history of the new town was its being the birthplace of Sejanus, the favourite of Tiberius. Its present population is only 2690. The Lake of Bolsena is about 10 miles in length by 8 in breadth, and is surrounded by well-wooded hills. It contains two small islands, Bisentina and Martana, in the latter of which Amalasontha, the wife of Theodatus, king of the Goths, was put to death by his orders.

BOLTON, or BOLTON LE MOORS, a municipal and parliamentary borough of England, in the county of Lancashire, 11 miles N.W. of Manchester, in 53° 35′ N. lat. and 2° 37′ W. long. It is divided by the Croal, a small tributary of the Irwell, into Great and Little Bolton, the former of which is situated on the south side of the stream. The town is on the whole well arranged and well built, and great improvements and extensions have been effected since 1860. An abundant supply of water is obtained from the neighbouring hills and stored in reservoirs at Belmont, Sharples, and Heaton. The waterworks, formerly in the hands of a company founded in 1824, have been the property of the corporation since 1847. The water rises by natural pressure to a height of 80 feet. Bolton possesses a large number of churches, but few are remarkable for either antiquity or architecture. The parish church of St Peter's, a building of somewhat early date, was rebuilt in an elaborate style about 1868. Among the educational establishments may be mentioned Lever's Grammar School, founded in 1641, where Dr Ainsworth, the Latin lexicographer, and Lemprière, of the *Classical Dictionary*, were formerly masters. A new town-hall, a market hall, a fish-market, an exchange, a theatre, and assembly rooms, are among the chief buildings. There are several public libraries and a mechanics' institute; and in 1855 a large Church of England institute was erected. During the great cotton famine the unemployed operatives were set to work on a large public park, which was opened in 1866. The cotton manufacture in various departments is still the most important in the town; in 1871 it gave employment to 8708 men and 11,353 women of twenty years of age and upwards. Various other industries, however, are extensively carried on. In 1871, 1030 adult workmen were employed in the manufacture of machinery, and 2524 in the iron manufacture; while silk-weaving was the occupation of 881, linen-weaving of 289, and paper-making of 306. Bleaching is also extensively carried on, and there are chemical works, dye-works, and calico-printing establishments. The coal mines in the neighbourhood give employment to nearly 4000 miners. Bolton is a place of some antiquity, but had little importance till the introduction of the woollen manufacture by Flemish immigrants about 1337. Several centuries afterwards its industries received a further development from a body of French refugees, driven from their own country by the Edict of Nantes. During the civil war of the 17th century the inhabitants espoused the popular side, and their town was taken by storm in 1644 by the royalists under Prince Rupert and the earl of Derby. The 18th century saw a great stimulus given not only to Bolton but to all England by the inventions of Arkwright and Crompton, who were both natives of the parish. It was here that cotton velvets were made for the first time (in 1756) and muslins (1782) by means of machinery. In 1791 a canal was constructed from Manchester to Bolton, and in the following year an Act of Parliament was passed for enclosing Bolton Moor. This measure was soon succeeded by a large extension of the town, which has since continued to increase from year to year. The municipal borough, with an area of 1748 acres, contained in 1851 10,394 inhabited houses for a population of 61,171; and in 1861, 13,129 houses for a population of 70,395. In 1871 the borough, with an increased area of 1822 acres, included 16,286 houses, and the population was 82,853. The parliamentary borough, which owes its existence to the Reform Bill of 1832, returns two members to parliament.

Arms of Bolton.

BOLZANO, BERNHARD, Catholic theologian and philosopher, was born at Prague on the 5th October 1781. He distinguished himself by his proficiency in mathematics, a study for which he always retained a predilection, and in philosophy. At the age of twenty-four he took orders, and was appointed professor of the philosophy of religion at the philosophical faculty in Prague. His lectures, in which he endeavoured so to present the system of Catholic theology as to show its complete harmony with reason, were received with eager interest by the younger generation of thinkers. But his views met with much opposition; and it was only through the powerful protection of the Prince Archbishop Salm-Salm that he was enabled to retain his chair. At last, in 1820, he was accused of being connected with some of the students' societies, and was compelled to resign his professorship. Several doctrines extracted from his works were condemned at Rome, and he was suspended from his priestly functions. The remainder of his life was devoted to literary work. He died at Prague in 1848. Bolzano's works are very numerous, filling, according to Erdmann, twenty-five volumes. The most important are the *Wissenschaftslehre* (4 vols., Sulzbach, 1837), containing some admirable discussions on logic, and the *Lehrbuch der Religions-wissenschaft* (4 vols., Sulzbach, 1834), which contains a philosophic representation of all the dogmas of the Catholic theology. In some respects it resembles the earlier work of Georg Hermes, for whom Bolzano had a great veneration. Some of the best of his minor works are on the philosophy of mathematics; such are—*Betrachtungen über Elementargeometrie*, *Beiträge zur begründeteren Darstellung der Mathematik*, *Begründung der Lehre von der drei Dimensionen des Raums*. (See *Lebensbeschreibung des Dr Bolzano* (an autobiography), 1836; Wisshaupt, *Skizzen aus dem Leben Dr Bolzanos*, 1850. A good account of Bolzano's philosophical position will be found in Erdmann, *Grundriss der Ges. d. Phil.*, ii. p. 385. 899.)

BOMBAY

BOMBAY, a Presidency and Governorship of British India, consisting partly of British districts, and partly of native states under the protection of Her Majesty's Indian Government. This territory extends from 28° 32′ to 13° 65′ N. lat., and from 66° 43′ to 76° 20′ E. long.; and is bounded on the N. by Beluchistán, the Panjáb, and the native states of Rájputáná; on the E. by the native state of Indor, the Central Provinces, West Berar, and the Nizám's dominions; on the S. by Madras and Mysor; and on the W. by the Arabian Sea. Area, including Sindh, 188,195 square miles, viz., 124,943 British, and 63,252 under Native rule. Population, 25,624,696 souls, viz., British districts, 16,352,623; Native states, 9,272,073. Bombay Presidency comprises three British divisions or commissionerships, the northern, the southern, and the Sindh divisions, with the following 24 districts:—Bombay, Ahmadábád, Kairá, Pánch Mahals, Broach, Surat, Tánná, Kolábá, Khándesh, Násik, Ahmadnagar, Belgám, Kánárá, Dhárwár, Káladgí, Púná, Ratnágiri, Sátárá, Sholápur, Upper Sindh Frontier, Karáchí, Haidarábád, Shikárpur, and Thar Párkar. The Native states are under the supervision of British political officers, and are divided into 16 agencies, viz., Baroda, Kachh, Káthiáwár, Kairá, Surat, Sholápur, Sátárá, Kolhápur, South Marhattá Country, Rewákánta, Máhikánta, Páhlanpur, Sáwantwárí, Tanná, Kolábá, and Dhárwár. The Presidency also includes the Portuguese possessions of Dáman, Diu, and Goa.

PHYSICAL ASPECTS.—The Bombay Presidency consists of a long strip of land along the Indian Ocean from the south of the Panjáb to the north of Mysor, from 25° to 14° 3′ N. lat. The coast is rock-bound and difficult of access; and though it contains several bays forming fair-weather ports for vessels engaged in the coasting trade, Bombay, Karáchí in Sindh, and Kárwár alone have harbours sufficiently land-locked to protect shipping during the prevalence of the south-west monsoon. The coast-line is regular and little broken, save by the Gulfs of Kambay and Kachh, between which lies the peninsula of Káthiáwár.

Mountains.—Speaking generally, a range of hills, known as the Western Ghâts (ghauts), runs down the coast, at places rising in splendid bluffs and precipices from the water's edge, at others retreating inland, and leaving a flat fertile strip of 5 to 50 miles between their base and the sea. In the north of the Presidency on the right bank of the Indus, the Hálá mountains, a continuation of the great Sulaimán range, separate British India from the dominions of the Khán of Khelát. Leaving Sindh, and passing by the ridges of low sand hills,—the leading feature of the desert east of the Indus,—and the isolated hills of Kachh and Káthiáwár, which form geologically the western extremity of the Aravali range, the first extensive mountain range is that separating Gujarát from the states of Central India. The rugged and mountainous country south of the Taptí forms the northern extremity of the Sáhyádri or Western Ghâts. This great range of hills, sometimes overhanging the ocean, and generally running parallel to it at a distance nowhere exceeding 50 miles, with an average elevation of about 1800 feet, contains individual peaks rising to more than double that height. They stretch southwards for upwards of 500 miles, with a breadth of 10 to 20 miles. The western declivity is abrupt, the land at the base of the hills being but slightly raised above the level of the sea. As is usually the case with the trap formation, they descend to the plains in terraces with abrupt fronts. The landward slope is in many places very gentle, the crest of the range being sometimes but slightly raised above the level of the plateau of the Dakhín. Their best-known elevation is Mahábaleshwar, 4800 feet high, a fine plateau, 37 miles from Púna, covered with rich vegetation, and used by the Bombay Government as its summer retreat and sanitarium. In the neighbourhood of the Sáhyádri hills, particularly towards the northern extremity of the range, the country is rugged and broken, containing isolated peaks, masses of rock, and spurs, which, running eastward, form watersheds for the great rivers of the Dakhín. The Sátpurá hills separate the valley of the Taptí from the valley of the Narbadá, and the district of Khándesh from the territories of Indor. The Sátmálá or Ajantá hills, which are rather the northern slope of the plateau than a distinct range of hills, separate Khándesh from the Nizám's dominions.

Plains.—The more level parts of Bombay consist of five well-demarcated tracts—Sindh, Gujarát, the Konkan, the Dakhín or Deccan, and the Karnatic. Sindh, or the lower valley of the Indus, is very flat, with but scanty vegetation, and depending for productiveness entirely on irrigation. Gujarát, except on its northern parts, consists of rich, highly cultivated alluvial plains, watered by the Táptí and Narbadá, but not much subject to inundation. The Konkan lies between the Western Ghâts and the sea. It is a rugged and difficult country, intersected by creeks, and abounding in isolated peaks and detached ranges of hills. The plains of the Dakhín and Khándesh are watered by large rivers, but as the rainfall is uncertain, they are generally, during the greater part of the year, bleak and devoid of vegetation. The Karnatic plain, or the country south of the River Krishná, consists of extensive tracts of black or cotton soil in a high state of cultivation.

Rivers.—The chief river of Western India is the Indus, which enters the Presidency from the north of Sindh, and flowing south in a tortuous course, falls into the Arabian Sea by several mouths, such as the Ghizrí creek, Khudí creek, Pitiání creek, Sisá creek, Hajámrí creek, Vatho creek, Mall creek, Wárí creek, Bhitiárá creek, Sir creek, and Khorí creek. In the dry season the bed varies at different places from 480 to 1600 yards. The flood season begins in March and continues till September, the average depth of the river rising from 9 to 24 feet, and the velocity

sea near the head of the Gulf of Kambay. The streams which, rising in the Sáhyádri range, or Western Gháts, flow westward into the Arabian Sea, are of little importance. During the rains they are formidable torrents, but with the return of the fair weather they dwindle away, and during the hot season, with a few exceptions, they almost dry up. Clear and rapid as they descend the hills, on reaching the lowlands of the Konkan they become muddy and brackish creeks. The Kanarese rivers have a larger body of water and a more regular flow than the streams of the Konkan. One of them, the Sheráwati, forcing its way through the western ridge of the Gháts, plunges from the high to the low country by a succession of falls, the principal of which is 890 feet in height. The Sáhyádri, or Western Gháts, also throw off to the eastward the two principal rivers of the Madras Presidency, the Godávarí and the Krishná. These rivers collect countless tributary streams, some of them of considerable size, and drain the entire plain of the Dakhin as they pass eastward towards the Bay of Bengal.

Lakes.—The Manchar Lake is situated on the right bank of the Indus. During inundations it attains a length of 20 miles, and a breadth of 10, covering a total area estimated at 180 square miles. But the most peculiar lacustrine feature of the Presidency is the Ránn or Lake of Kachh (*Cutch*), which, according to the season of the year, is a salt marsh, an inland lake, or an arm of the sea. Its area is estimated at 8000 square miles. It forms the western boundary of the province of Gujarát, and when flooded during the rains, unites the Gulfs of Kachh (Cutch) and Kambay, and converts the territory of Kachh into an island. In the dry season the soil is impregnated with salt, the surface in some places being moist and muddy, and in others, like a dry river bed or sea-beach, strewn with gravel or shingle. The Ránn is now used as the great source of salt supply for the whole Presidency. Its present condition is probably the result of some natural convulsion. But whether the Ránn is an arm of the sea from which the waters have receded, or an inland lake whose seaward barrier has been swept away, still remains a matter of discussion.

Climate.—Great varieties of climate are met with in the Presidency. In its extreme dryness and heat, combined with the aridity of a sandy soil, Upper Sindh resembles the sultry deserts of Africa. The mean maximum temperature at Haidarábád, in Lower Sindh, during the six hottest months of the year, is 98° 5′ in the shade, and the water of the Indus reaches blood heat; in Upper Sindh it is even hotter, and the thermometer has been known to register 130° in the shade. In Kachh and in Gujarát the heat, though less, is still very great. The Konkan is hot and moist, the fall of rain during the monsoon sometimes approaching 300 inches. The table-land of the Dakhin above the Gháts, on the contrary, has an agreeable climate except in the hot months, as has also the southern Marhattá country; and in the hills of Mahábaleshwar, Singarh, and other detached heights, Europeans may go out at all hours with impunity. Bombay Island itself, though in general cooled by the sea breeze, is oppressively hot during May and October. The south-west monsoon generally sets in about the first week in June, and pours down volumes of rain along the coast. From June to October travelling is difficult and unpleasant, except in Sindh, where the monsoon rains exert little influence.

Forests.—Bombay Presidency possesses two great classes of forests—those of the hills and those of the alluvial plains. The hill forests are scattered over a wide area, extending from 23° to 14° N. lat. Most of them lie among the Sáhyádri hills or Western Gháts. The alluvial forests lie in Sindh, on or close to the banks of the Indus, and extend over an area of 550 square miles. The principal timber trees in the forests are—teak; blackwood of two varieties (*Dalbergia Sisu* and *Dalbergia latifolia*), *Dalbergia ujainensis*, *Pterocarpus Marsupium*, *Terminalia glabra*, *Acacia arabica*, *Acacia Catechu*, *Nauclea cordifolia*, *Nauclea parvifolia*, *Bidelia spinosa*, *Hardwickia binata*, *Juga xylocarpa*, *Populus euphratica*, and *Tamarix indica*. The forests contain many trees which, on account of their fruits, nuts, or berries, are valuable, irrespective of the quality of their timber. Among these are the mango (*Mangifera indica*); the jack (*Artocarpus integrifolia*), *Zizyphus Jujuba*, *Ægle Marmelos*, *Terminalia Chebula*, *Calophyllum Inophyllum*, *Bassia latifolia*, and *Pongamia glabra*. The jungle tribes collect gum from several varieties of trees, and in Sindh the Forest Department derives a small revenue from lac. The palms of the Presidency consist of cocoa-nut, date, palmyra, and areca catechu.

Geology.—Geologically the Bombay Presidency is divided into two tracts: the north-western part, consisting of Sindh, Kachh (Cutch), and Gujarát; and the south-western, comprising the Marhattá country. Undulating sandy plains, with scattered craggy hills, are found in Gujarát; the immense alluvial flats to the north being, for the most part, deserts of blown sand, and the fertile country consisting of a belt along the borders of the sea. In Sindh, the country, except on the banks of the Indus, or where reclaimed by irrigation, is an arid tract of gravel and sand, from which rise steep scarps of limestone ranges. The rocks of Gujarát, Kachh, and Sindh, are only partially represented in the more southern peninsula, and are continuous with the formations found in Persia and Arabia. In the Marhattá country the greater portion of the surface is composed of nearly horizontal strata of basalt and similar rocks.

POPULATION.—The census of 1872 returns the total area of the Presidency, including Sindh, at 188,195 square miles, and the total population at 25,624,696 souls. Details, however, are only available for the British part of the Presidency, which contains an area of 124,943 square miles, and a total population of 16,352,623 souls. The average density of population in the British districts is 131 persons per square mile, but it varies from a maximum of 29,291·13 in Bombay city to 14·20 in Thar and Párkar. Total number of houses in the British districts, 2,164,338; and average number of persons per house, 4·99. Of the total population of the British portion, 12,440,659, or 76·08 per cent., are Hindus; 2,847,756, or 17·4 per cent., Muhammadans; 192,245, or 1·17 per cent., Buddhists; 106,133, or 0·65 per cent., Christians; 67,115, or 0·41 per cent., Pársís; 603,836, or 3·69 per cent., aborigines; and 94,879, or 0·58 per cent., of unspecified religion or nationality. The males number 8,547,100, or 52 per cent. of the population; the females, 7,805,523, or 48 per cent. The percentage of the total number of children under twelve years of age is 31·65. The Hindus are most numerous in Satára, and fewest in the Upper Sindh Frontier district. The Muhammadans form nearly the whole population of Sindh, and are least numerous in the Pánch Mahals. Except in Sindh, the Buddhists are widely scattered throughout the whole Presidency. The Christians are chiefly confined to Bombay city, Tánná, the Indo-Portuguese possessions, and the larger cantonments, such as Púna. The British districts of the Presidency contain upwards of 26,800 villages, and 175 towns of upwards of 5000 inhabitants. Besides Bombay city, there are 213 municipalities established under Act 26 of 1850. Of these, 4 have an income of over £10,000; 27 of over £1000; 22 of over £500; 94 of over £100; and 66 of under £100. Exclusive of the town of Bombay, the total municipal revenue realised in 1872–73 amounted to £198,857. Average rate of municipal taxation, 2s. 1½d. per head of the town population. The principal sources of municipal

revenue are the *octroi* duties, house tax, and wheel tax.

Agricultural Products.—The staple crops are as follows:—Joár (*Sorghum vulgare*) and bájrá (*Holcus spicatus*) are the staple food grains in the Dakhin and Khándesh. Rice is the chief product of the Konkan. Wheat, generally grown in the northern part of the Presidency, but specially in Sindh and Gujarát, is exported to Europe in large quantities from Karáchí, and on a smaller scale from Bombay. Barley is principally grown in the northern parts of the Presidency. Náchaní (*Eleusine coracana*) and Kodrá (*Paspalum scrobiculatum*), inferior grains grown on the hill sides, furnish food to the Kulís, Bhils, Wáralis, and other aboriginal tribes. Of the pulses the most important are gram (*Cicer arietinum*), túr (*Cajanus indicus*), kultí (*Dolichos biflorus*), and mug (*Phaseolus Mungo*). Principal oil-seeds: til (*Sesamum orientale*), mustard, castor-oil, safflower, and linseed. Of fibres the most important are cotton, Dakhiní hemp (*Hibiscus cannabinus*), and san or tág (*Crotolaria juncea*). Much has been done of late years to improve the cotton of the Presidency. American varieties have been introduced with much advantage in the Dhárwár collectorate and other parts of the southern Marhattá country. In Khándesh the indigenous plant from which one of the lowest classes of cotton in the Bombay market takes its name, has been almost entirely superseded by the superior Hinganghát variety. Miscellaneous crops:—Sugar-cane, requiring a rich soil and a perennial water supply, and only grown in favoured localities, red pepper, potatoes, turmeric, and tobacco. In 1871–72, 3,379,937 acres were under cotton cultivation; in 1872–73 the area increased to 3,715,945 acres. The total out-turn was 260,444 *candies* (560 lb) in 1872–73, against 221,144 in 1871–72. A legislative enactment has been passed to prevent adulteration of cotton, and in 1872–73, 24 persons were convicted under it. In 1872–73, 2281 steam cotton gins were at work with 158 steam presses. Two model farms have been established in the Presidency—one at Hálá, near Haidarábád, in Sindh, and the other in Khándesh. Experiments have been instituted in the cultivation of fibres and tobacco. Large quantities of Carolina rice seed were distributed over the country, but the results hitherto cannot be deemed to have been successful. The same may be said of the endeavours which have been made to propagate the cinchona tree near Mahábaleshwar. Acreage under principal crops—Joár, 6,552,385 acres; bajrá, 4,560,271; rice, 2,009,115; wheat, 1,322,835; and pulses, 1,167,809 acres. The land system of the Presidency is complicated, each province having a variety of tenures of its own. But the most important, and by far the most universal, is the survey tenure created by the British administration, which gives a right of occupancy to the holder on condition of his paying the Government demand.

Public Works and Railways.—In 1872–73 the sum of £1,180,000 was expended on account of Public Works in the Bombay Presidency; and the allotment under this head tends annually to increase. In the same year there were five railways open—1. The Great Indian Peninsula Railway: total miles open, 1278; total capital invested, £25,569,568; total receipts during the year, £1,872,826; working expenses, £1,203,200; net profit, £669,626. 2. The Bombay, Baroda, and Central India Railway: miles open, 389; capital invested, £8,418,202; receipts, £564,931; working expenses, £338,786; net profit, £226,145. 3. The Khámgáon State Railway: miles open, 8; capital invested, £48,530; receipts, £1241; working expenses, £562; net profit, £679. 4. The Amráoti Railway: miles open, 5½; capital invested, £43,730; receipts, £2302; working expenses, £1241; net profit, £1061. 5. The Sindh section of the Sindh Panjáb and Dehli Railway: miles open, 106; capital invested, £2,646,106; receipts, £157,100; working expenses, £118,934; net profit, £38,166. Total miles open of the above five railways, 1786½; total capital invested, £36,726,136; total receipts in 1872, £2,598,400; total working expenses, £1,662,723; total net profit, £980,667. Besides these, the following railways are either in progress or about to be undertaken:—(1), State line, Southern Marhattá country; (2), Native State line, Viráwal, Junágarh, and Dhoráji; (3), Pátrí Branch (State line, light rail); (4), Anand and Dákor Branch; (5), Migángáon and Dhaboi Railway; (6), Wardhá to Hinganghát and Waroră: (7), Wadi to Haidarábád; (8), Khandwá to Indor. In 1872–73 the Bombay Telegraph Department had 4406 miles of wire in operation.

Post-Offices.—In 1872–73, 447 post-offices were distributed over the Presidency; total mileage of postal lines, 10,208 miles; total number of letters, parcels, &c., despatched and received, 17,601,982.

Mines and Quarries.—The Presidency of Bombay though deficient in mineral wealth, is abundantly supplied with stores of stone fitted for building and road-making purposes. At Teagar, in the Dhárwár district, iron-ore is mined and smelted, but the scarcity of fuel prevents operations being conducted on an extensive scale. There are also large slate quarries in Dhárwár. Mándargé hill is quarried extensively for stone, the right of working it being annually sold by public auction. In Belgám district are quarries, from which building stones, stone bricks, or oblong quadrangular blocks of soft rock are obtained in abundance. Limestone is also found in the river beds of this district. There are a few trap and laterite quarries in the Ratnágiri district. The trap stone is used for tank and well building, and for the plinths of houses; the laterite is used for house-building. Near Karáchí are five quarries containing a species of limestone, largely used in buildings in that town.

Manufactures.—The indigenous manufactures of the country have rapidly declined since the influx of Manchester goods. But cotton weaving is still carried on upon a small scale in every village of any importance. Dyeing is practised in most places where fresh water is procurable. Printed cotton goods are manufactured in all the large towns of Gujarát, and the further the locality is removed from the direct influence of railways the better the work is. This is owing to the competition of European cotton goods, which are sold much cheaper, and are more brilliant in colour, although less strong and durable, than the native manufactures. Most of the lower classes still wear home-spun and woven goods; but the cotton-mills erected in

that number; and the low rates of wage, with the natural aptitude of the native for textile work, enables the Bombay mill-owners to compete with the Lancashire manufacturers, notwithstanding the heavy cost of importing machinery and of European supervision. Several of the mills have a capital of some hundreds of thousands sterling invested in them; and their superior reputation for turning out unglazed and genuine goods has almost driven the lower qualities of Manchester fabrics from the market. In 1873 fifteen mills were at work in the town and island of Bombay, and five in other parts of the Presidency. Most of them have both spindles and looms, and their yarn and piece goods find a ready market. In Ahmadábád, Surat, Yeolá, Násik, and Bombay, considerable quantities of silk goods are made, the silk being imported from China either in the cocoon or in skeins. Gold and silver thread enter largely into the manufacture of silk and cotton fabrics. The *kinkháb* (kincob), the richest kind produced, is either gold thread and silk, or silver, gold, and silk. Embroidery in silk cloth and cotton, and in gold, silver, and silk thread, is carried on to some extent in Haidarábád, in Sindh, principally for European markets. Fibres are used for the manufacture of paper in Ahmadábád, Baroda, Surat, Násik, Bombay, and Kolhápur. Mats, beds, &c., are manufactured from cocoa-nut fibre. Leather is worked into a variety of articles throughout the Presidency. The manufactures of minor importance consist of pottery, brass, and copper utensils, cutlery, and agricultural implements, gold and silver ornaments, carved wood, ivory work, &c.

TRADE.—The total value of the external trade of the Presidency for 1872–73 was as follows:—Bombay Port—imports, £17,388,953; exports, £19,117,081; re-exports, £5,140,924; total, £41,646,958. Minor ports—imports, £395,238; exports, £729,028; re-exports, £13,368; total, £1,137,634. Sindh ports—imports, £1,677,399; exports, £1,991,556; total, £3,668,955. Aden—imports, £1,407,102; exports, £834,087; total, £2,241,189. Total of the Presidency — imports, £20,868,692; exports, £22,671,752; re-exports, £5,154,292; total, £48,694,736. In the same year 5314 ships, having a tonnage of 902,157 tons, cleared from Bombay harbour, and 5208 ships, of 161,907 tons, from the minor ports. Principal articles of commerce—cotton, cotton piece-goods, wool and woollen piece goods, machines and machinery, oils, tea, wines and spirits, metals, coal, candles, jute and gunny cloths, apparel, sugar and sugar-candy, twist, hides and skins, grain and pulse, bullion, &c. In 1872–73 upwards of 55,300 tons of cotton were imported into Bombay in the shape of Manchester goods, and 143,017 tons of raw cotton exported from it.

REVENUE AND EXPENDITURE.—The total revenue of the Presidency for the year 1872–73 amounted to £9,980,043, and the expenditure to £8,027,040. The principal heads of revenue are as follows:—Land revenue, £3,751,050; tributes and contributions from native states, £92,337; forests, £114,640, excise, £418,746; assessed taxes, £110,098; customs, £667,825; salt, £885,013; opium, £2,614,897; stamps, £527,382; law and justice, £29,677; marine, £64,475; interest, £103,209. The settlement of the land revenue is usually made for thirty years. A revision of the thirty years' settlement of Poona, Násik, and Sholápur districts, is now (1874) in progress.

STATISTICS OF PROTECTION.—The military strength of the Bombay Presidency consists of 1250 European commissioned officers, 11,067 European non-commissioned officers and rank and file, 27,002 Native commissioned and non-commissioned officers and rank and file; total, 39,319. The whole are under the control of a separate commander-in-chief for Bombay. Ten ships constitute the strength of the Bombay marine. The regular police of Bombay consisted in 1872–73 of 18,166 officers and men, maintained at a total cost of £305,810; the average being 1 man to every 6·8 square miles of the area, and to 900 of the population.

EDUCATION.—The University of Bombay, established in 1857, is a body corporate, consisting of a chancellor, vice-chancellor, and fellows. The Governor of Bombay is *ex-officio* chancellor. The Educational Department is under a director of public instruction, who is responsible for the administration of the department in accordance with the general educational policy of the state. In 1872–73 the number of schools and colleges aided by the state or under its inspection was as follows:—7 colleges, attended by 544 pupils; 4 professional schools, with 275 pupils; 41 high schools, 7167 pupils; 176 middle class schools, 16,612 pupils; 3595 lower class schools for boys, 182,147 pupils; 253 lower class schools for girls, 10,885 pupils; 12 normal schools, 602 pupils; total, 4088 schools, 218,466 pupils. The total cost for the schools was £285,650, of which the state contributed £99,600; the balance being obtained from school fees, local contributions, private endowments, &c.

HISTORY.—The territories now comprising the Presidency of Bombay formed in ancient times several separate Hindu kingdoms, among which Mahárásthra, Gujarásthra, Sindhu, were the most important. As in other parts of India, the great majority of the people are Hindus, with more recent accretions of Muhammadans, and a sprinkling of hill-tribes practising non-Hindu rites, and representing the pre-Aryan races. The first Muhammadan invasion of which we have authentic accounts is that of Mahmúd of Ghazní, who, in 1024 A.D., invaded Gujarát with a large army, destroyed the national Hindu idol of Somnáth, and carried away an immense booty. Muhammad Ghorí also invaded Gujarát, and left a garrison in its capital. But it was not till after the Musalmán power was firmly established in Northern India that the Muhammadan sovereigns of Dehli attempted the conquest of the south. In 1294 the Emperor Alá-ud-din first invaded the Dakhin (Deccan), and in 1297 he conquered Gujarát. In 1312 the Muhammadan arms were triumphant through the Marhattá country; and seven years later the whole of Malabar fell a prey to the invaders. In the middle of the 14th century the weakness of the Dehli sovereigns tempted the governors of provinces to revolt against their distant master, and to form independent kingdoms. In this way the Báhminí kingdom was established in the Dakhin, and embraced a part of the Bombay Presidency. Ahmadnagar and Gujarát also became the seats of a new kingdom. In 1573 Akbar conquered Gujarát and reannexed it to the empire, and in 1601 he effected the reconquest of Ahmadnagar and Khándesh. From this time the country was never tranquil, and Ahmadnagar became the focus of constant rebellions. During the latter part of the 17th century the Marhattás rose into power, and almost every part of the country now comprising the Presidency of Bombay fell under their sway.

As early as 1532 A.D. the island of Bombay was occupied by the Portuguese. The Dutch and English made an unsuccessful attempt to gain possession of the island in 1627, and in 1653 proposals were suggested for its purchase from the Portuguese. In 1661 it was ceded to the English Crown, as part of the dower of the Infanta Catherina on her marriage with Charles II. So lightly was the acquisition esteemed in England, and so unsuccessful was the administration of the Crown officers, that in 1668 Bombay was transferred to the East India Company for an annual payment of £10. The population at that time did not exceed 10,000 souls, and so unhealthy was the climate, that three years were regarded as the average duration of the life of its European inhabitants. At the time of the

transfer, powers for its defence and for the administration of justice were also conferred; a European regiment was enrolled; and the fortifications erected proved sufficient to deter the Dutch from their intended attack in 1673. In 1687 Bombay was placed at the head of all the Company's possessions in India; but in 1753 the Government of Bombay became subordinate to that of Calcutta. The first English settlement in the Bombay Presidency was in 1618, when the East India Company established a factory at Surat, protected by a charter obtained from the Emperor Jahángír. After the termination of the second Marhattá war in 1803, the East India Company obtained the districts of Surat, Broach, Kairá, &c.; and on the overthrow of the Peshwá in 1818, they annexed Púná, Ahmadnagar, Násik, Sholápur, Belgám, Kálaugí, Dhárwár, &c. Sindh was conquered in 1843, and became a part of the British empire. The native states under the supervision of the Government of Bombay are divided, historically and geographically, into two main groups. The northern or Gujarát group includes the territories of the Gaikwár, with the smaller states which form the administrative divisions of Kachh, Páhlanpur, Rewá Kánta, and Máhi Kánta. These territories, with the exception of Kachh (Cutch), have an historical connection, as being the allies or tributaries of the Gaikwár in 1805, when final engagements were concluded between that prince and the British Government. The southern or Marhattá group includes Kolhápur, Akalkot, Sáwantwárí, and the Sátárá and southern Marhattá Jágírs, and has an historical bond of union in the friendship they showed to the British in their final struggle with the power of the Peshwá in 1818. The remaining territories may conveniently be divided into a small cluster of independent zamíndáris, situated in the wild and hilly tracts at the northern extremity of the Sáhyádri range, and certain principalities which, from their history or geographical position, are to some extent isolated from the rest of the Presidency.

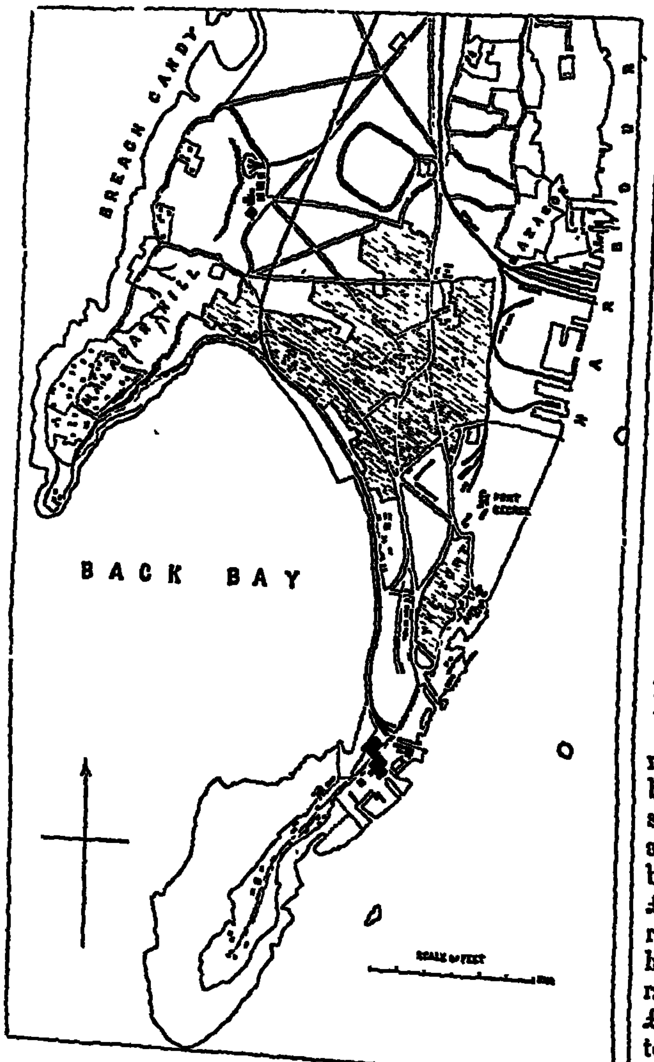
Administration.—The Government of Bombay is administered by a Governor in Council, the latter consisting of the Governor as president, two ordinary civil members, and, as a rule, the commander-in-chief of the Bombay army. These are the executive members of Government. For making laws there is a legislative council, consisting of the Governor and his Executive Council, with certain other persons, not fewer than four or more than eight in number, nominated by the Governor to be members of council for legislative purposes only, and intended to represent the non-official European and Native communities. Each of the members of the Executive Council has in his charge one or two departments of the Government; and each department has a secretary, an under-secretary, and an assistant secretary, with a numerous staff of clerks. The political administration of the native states is under the superintendence of British agents placed at the principal native courts; their position varies in different states according to the relations in which the principalities stand with the paramount power. The administration of justice throughout the regulation districts of the Presidency is conducted by a High Court at Bombay, consisting of a Chief Justice and seven Puisne judges, along with district and assistant judges throughout the districts of the Presidency. The revenue administration of the regulation districts is carried on by two revenue commissioners, seventeen collectors, twenty assistant collectors, and a varying number of supernumerary assistants. (W. W. H.)

Bombay City and Island.

The Island of Bombay, with an area slightly in excess of 22 square miles, is situated in 18° 53' 54" N. lat., and 72° 52' E. long. It consists of a plain about 11 miles long by 3 broad, flanked by two parallel lines of low hills. A neck of land stretching towards the south-west forms the harbour on its eastern side, sheltering it from the force of the open sea, and enclosing an expanse of water from 5 to 7 miles wide. At the south-west of the island, Back Bay, a shallow basin rather more than 2 miles in breadth, runs inland for about 3 miles between the extreme points of the two ranges of hills. On a slightly raised strip of land between the head of Back Bay and the harbour is situated the fort, the nucleus of the city of Bombay. From this point the land slopes westward towards the central plain, a low lying tract, which before the construction of the embankment known as the Hornby Velard, used at high tide to be submerged by the sea. To the north and east, although causeways and railway embankments have now shut out the sea, a large area of salt-marsh land still remains subject to inundation.

In the foregoing article on the Bombay Presidency it is explained that Bombay Island passed to the English Crown as part of the dower of the Infanta Catherina, on her marriage with Charles II., and that although the new acquisition was at first despised, it rose in 1687 to the chief importance in the East India Company's possessions. In the next century it declined before the growth of Calcutta, and sank into a subordinate settlement. The present century has again witnessed a revolution in its fortunes. Its splendid harbour and comparative nearness to the Suez Canal, with the system of railways which now connect Bombay with the other Presidencies, have marked out for it a career scarcely second, if at all second in commercial importance, to that of Calcutta itself. The sudden demand for Indian cotton, which resulted from the American war, gave an unprecedented rapidity to its development. The cotton of Gujarát, Dhárwár, and other parts of Bombay, is much superior to the Bengal fibre. Several years of brilliant prosperity culminated in 1866–67 in a financial crisis, that left the commerce of Bombay in a shattered state. Depending as it does chiefly on the one article of cotton, along with some export of grain and the Government opium, the trade of Bombay rests on a narrower basis than that of Calcutta, which in years of misfortune has a large variety of staples to fall back upon, such as tea, indigo, jute, rice, hides, oil-seeds, &c. Moreover, Bombay has only the costly railway communication with the interior parts of India, while Calcutta commands the confluence of two of the greatest river systems in the world, the Brahmaputra and the Ganges. Nevertheless, Bombay is pressing close upon Calcutta as the commercial capital of India. Its imports are about as great, and its exports not very far short. In 1871–72 its total trade was £50,384,929 against a total of £54,136,829 in Calcutta. In that year the Bombay imports were 22½ millions sterling; the exports, 23½ millions, and the re-exports, 4½ millions: total, 50½ millions sterling.

buildings are on the American scale, and have no rival in any other city of India. The private houses of the European residents lie apart alike from the native and from the mercantile quarters of the town. As a rule, each is built in a large garden or *compound;* and although the style of architecture is less imposing than that of the stately residences in Calcutta, it is well suited to the climate, and has a beauty and comfort of its own. The favourite suburb is Malabar hill, a high ridge running out into the sea, and terraced to the top by handsome houses, which command one of the finest views in the world. To the right of this ridge, looking towards the sea, runs another suburb known as Breach Candy, built close upon the beach and within the refreshing sound of the waves. To the left of Malabar hill the island forms a spacious bay, with a



Ground-Plan of Bombay.

promontory at the other side, which marks the site of the old Bombay Fort. The fort is now a mere garrison, with small pretensions to defensive capabilities. Its walls are demolished, and its area is chiefly devoted to mercantile buildings. Further round the island, beyond the fort, is Mazagon Bay, commanding the harbour, and the centre of maritime activity. The defences of the port consist chiefly in ironclad "Monitors" anchored off the town, with one or two fortified islands, and the guns which still line a portion of the old fort walls that have been left standing towards the sea. The census of 1872 disclosed a population of 644,405 souls; of whom 408,680, or 63·42 per cent., are Hindus; 138,815, or 21·54 per cent., Muhammadans; 44,091, or 6·84 per cent., Pársís; 15,121, Buddhists and Jains; 34,705, or 5·39 per cent., European, African, Eurasian, and Native Christians, with 2993 classified under the head of "others." Dyeing, tanning, and working in metals may be noticed as specially active trades, but the most progressive and important industry is the manufacture of yarn and cotton cloth. In 1873 there were 5 steam spinning and weaving mills in Bombay, giving employment to about 11,000 hands. In these factories 380,000 spindles and 5000 looms were at work. A considerable section of the population is supported by the cultivation of cocoa-nut trees and the preparation of intoxicating drinks from the juice of the different species of palm. Rice is the chief agricultural product, but many varieties of garden vegetables are profitably cultivated. Of these the most common are onions, "bhendis" (*Abelmoschus esculentus*), and gourds of different sorts. The imperial revenue from the town and island of Bombay is derived from two sources,—the one supervised by the collector of Bombay, the other by the commissioner of customs. The total receipts for the past year, under the first head, amounted to £148,287, of which £23,131 was derived from land, £17,250 from excise, and £107,906 from stamps. The total amount collected by the commissioner of customs was £3,252,714, of which the customs yielded £609,630, and the export duty on opium £2,643,084. Owing to the difficulty of procuring colonists in the early days of the settlement, the land is generally held on easy terms,—the payment to Government being in most cases of the nature of a quit rent, free from enhancement or resettlement as long as the land is used for cultivation only. Of the whole area, 13 miles are returned as cultivated, and 9 as unculturable. During the year 1872 there were 101 schools in Bombay, attended by 11,351 scholars, or 1 to every 56 of the entire population. The total strength of the local police force in 1872 was 1402, or 1 policeman to every 459 inhabitants. Of the entire number, 1124 are municipal, and 278 Government police. Of the former, 35 are European, and 13 are mounted Native police. The Government police are employed on harbour duty and as guards for Government offices. Eight of them are Europeans

Municipal Statistics.—The limits of the Bombay municipality extend over the whole of the island of Bombay, including, as stated above, a population of 644,405 souls. The total municipal revenue for the year 1873 amounted to £314,645, of which £223,041 was raised by taxation, £59,958 on account of services rendered, and £31,646 from municipal property and miscellaneous receipts The following are the main items under the head of taxation proper:—House rate, £73,587; police rate, £24,189; lighting rate, £21,179; wheel taxes, £23,197; tobacco and liquor duty and licenses, £28,690; town duties, £45,200; and additional rates from Port Trust, £4000. Under the head, Service rendered, are included the Halálkar cess and the water rate, yielding respectively £20,392 and £39,566. The returns under the third head are chiefly receipts from the Crawford markets. The total expenditure was £312,208. Of this amount £25,325 was spent on general supervision, £36,041 in supporting the police and fire brigade. Under the head of public health, £87,574 was spent, and £84,835 on public works. The interest and sinking fund on the police debt consumed £74,496. The incidence of municipal taxation per head of the population is 6s. 9d. It is estimated that the gross annual income of the city is about 855 lakhs of rupees, or upwards of 8½ millions sterling, on which sum the municipal taxation proper amounts to about 2·57 per cent., and the total municipal income and expenditure to about 3·64 per cent. The municipal debt at present amounts to about £790,000, or nearly 2½ years' income.

(W. W. H.)

BONALD, Louis Gabriel Ambroise, Vicomte de, philosopher and politician, was born at Monna, near Milhaud, in Rouergue, France, on the 2d October 1754. He served for some years in the king's musketeers, and after his marriage was made mayor of his native place. Dissatisfied with the revolutionary principles then being acted upon, he emigrated in 1791, and joined the army of the Prince of Condé. Soon afterwards he settled, with his family, at Heidelberg, where he wrote his first important work, *Théorie du pouvoir politique et réligieux dans la Société civile*, 3 vols., 1796, in which his conservatism and reactionary views are fully expounded and illustrated. In this work, too, he predicted the certain return of the Bourbons to France. The book was condemned by the Directory, and in France very few copies escaped detection. Naturally, on his return to his native country, M. de Bonald found himself an object of suspicion, and was obliged to live in retirement. He still continued to publish works of the same tendencies,—his *Essai analytique sur les Lois naturelles de l'ordre social* appearing in 1800, the *Législation primitive* in 1802, and the treatise *Du Divorce considéré au XIX^me Siècle* shortly after. In 1806 he was associated with Chateaubriand and Fiévée in the conduct of the *Mercure de France;* and two years later, after great persuasion, he allowed himself to be appointed councillor of the Imperial University, which he had often attacked. After the Restoration he was made member of the Council of Public Instruction, and from 1815 to 1822 he sat in the chamber as deputy. His speeches and votes were invariably on the extreme Conservative side; he even advocated a literary censorship. In 1822 he was made minister of state, and presided over the commission in whose hands the censorship rested. In the following year he was raised to the rank of peer, a dignity which he lost through refusing to take the oath in 1830. From 1816 onwards he had been a member of the Academy. He took no part in public affairs after 1830, but retired to his country-seat at Monna, where he died on the 23d November 1840.

Bonald was one of the most able and vigorous writers of the theocratic or reactionary school, which comprehended among its numbers such men as De Maistre, De Lamennais, Ballanche, and D'Eckstein. The great bulk of his writings belong to the department of social or political philosophy; but all the results at which he arrives are deductions from a few principles. The one truth which to him seemed, in fact, all-comprehensive was the divine origin of language. In his own somewhat enigmatic expression, *L'homme pense sa parole avant de parler sa pensée,* words and thoughts are inextricably linked together; the first language contained the essence of all truth. From this premise he draws his proof for the existence of God, and for the divine origin and consequent supreme authority of the Holy Scriptures. The infallibility of the church as the exponent of spiritual truth readily follows. While this thought lies at the root of all his speculations there is a formula of constant and significant application. All relations are by him reduced to the triad of cause, means, and effect, which he sees constantly repeated throughout all nature. Thus, in the universe there are the first cause as mover, movement as the means, and bodies as the result; in the state we have power as the cause, ministers as the means, and subjects as the effects; in the family we have the same relation exemplified by father, mother, and children. It is also to be remarked that these three terms bear specific relations to one another, the first is to the second as the second is to the third. Thus, in the great triad of the religious world,—God, the Mediator, and Man,—God is to the God-Man as the God-Man is to Man. It will be readily apparent how Bonald was able from these principles to construct a complete system of political absolutism, for the sufficiency of which only two things were wanted,—well-grounded premises instead of baseless hypotheses, and the harmony of the scheme with the wills of those who were to be subjected to it. Bonald's style is remarkably fine; ornate, but pure and vigorous. Many fruitful thoughts are scattered among his works, which have been popular with a certain party; but his system scarcely deserves the name of a philosophy.

Besides the above-mentioned works, Bonald published *Recherches Philosophiques sur les premiers objets de Connaissances Morales*, 2 vols., 1818; *Mélanges littéraires et politiques, Démonstration philosophique du principe constitutif de la Société*, 1830. The first collected edition appeared in 12 vols., 1817–19; the latest is that in 3 vols., with introductory notice by the Abbé Migne. See *Notice sur M. le Vicomte de Bonald*, 1841 (by his son), and Damiron, *Phil. en France au XIX^me Siècle.*

BONAPARTE, or, as it was originally spelled, Buonaparte, the name of the Italian family from whom the great Napoleon was descended. The father of the first emperor, Carlo Maria Bonaparte, was born at Ajaccio in 1746. He was a lawyer by profession, and took a vigorous part in Paoli's insurrection. In 1781 he was one of the members of the council of Corsican nobility; he also held the post of assessor of Ajaccio. In 1785 he died of cancer in the stomach at Montpellier, whither he had removed for his health. His wife, Letizia Ramolino, born in 1750, was celebrated for her majestic beauty and resolute courage. She accompanied her husband through the campaigns with Paoli, and in 1793 emigrated with her family to Marseilles, where for a time she lived in great penury. After her son was made first consul she removed to Paris, and, on the establishment of the empire, received the title of Madame Mère. She cared little for display; and her frugal style of living frequently displeased Napoleon. After the battle of Waterloo she took up her abode in Rome, where she continued to reside till her death in 1836. Of her large family of thirteen, eight survived their father and have become known in history. These in order of age are—

I. Joseph, the eldest son, born on the 7th January 1768. He was placed, along with his younger brother Napoleon, at the school of Autun, from which the latter was soon afterwards withdrawn. On completing his education he contemplated a military career, but, on the death of his father, devoted himself to the care of his family. He studied law at the University of Pisa, and was received as an advocate in Corsica. He and his brother eagerly embraced the revolutionary side, and in 1793 the whole family were compelled to emigrate to Marseilles. In the following year he married Mlle, Clary, daughter of a rich merchant, whose younger sister afterwards became the wife of Bernadotte. Two years later, when Napoleon was made general of the army of Italy, Joseph accompanied

useful only in so far as it contributed to the support of his own power. The Neapolitans soon discovered that their king was but a mouth-piece, and learned to despise him; and his rule was disturbed by constant insurrections. In the beginning of 1808 Napoleon began to communicate with his brother regarding the affairs of Spain; and finally, on the 10th May, wrote to him that the Spanish throne was vacant, and that he had destined it for him. Joseph, with many forebodings, was obliged to accept; and for a short time matters seemed sufficiently smooth. But the smouldering discontent soon broke out into open flame over the land, and the Spaniards, assisted by the British and Portuguese, made a struggle for freedom. Joseph's influence in the kingdom was a nullity; the people had never accepted him, and Napoleon, by giving absolute command to his various marshals, robbed his brother of all real power. Thrice the new king was compelled to fly from Madrid, and it was with difficulty that he escaped after the final battle of Vittoria. During the great struggle of 1814 Joseph acted as lieutenant-general of the empire, and as adviser-in-chief to the empress-regent. Under his brother's orders he sent off Maria Louisa and her son to Blois when the allied army approached Paris; and it was on his authority that Marmont treated for the capitulation of the city. For these acts he has sometimes been blamed, but with scant justice. While Napoleon was in Elba Joseph took up his residence in Switzerland; but he rejoined his brother in Paris during the Hundred Days. After the abdication he had an interview with the fallen emperor at the Isle of Aix, and generously offered to give up to him his own means o. escape. The proposal not being accepted, he sailed for America and settled near Philadelphia, at Point-Breeze, on the banks of the Delaware. Here he lived for some years under the title of Comte de Survilliers, endeared to the inhabitants by his liberality and gracious manners. After the July revolution of 1830 he wrote a long and eloquent letter, advocating the claims of his nephew, the duke of Reichstadt, to the French throne. Two years later he visited England, where he resided for some years, and to which he paid a second visit in 1839 In 1841 he was permitted to enter Genoa and Florence where his wife resided. In the latter city he died on the 28th July 1844. Joseph Bonaparte was of a handsome figure and commanding presence; his manners were peculiarly suave and courteous. Of all the brothers he seems to have been the only one personally loved by Napoleon. His wife, the daughter of a Marseilles merchant, died on the 7th April 1845. The elder of his two daughters, Zenaide Charlotte Julie (born 1801, died 1854), was married to her cousin Charles Bonaparte, son of Lucien; the younger, Charlotte (born 1802, died 1839), was married to Napoleon Louis, second son of Louis Bonaparte.

II. Napoleon, born 1769. See Napoleon I.

III. Lucien, Prince of Canino, was born at Ajaccio, 21st March 1775. He was educated at Autun, Brienne, and Aix, and rejoined his family in Corsica in 1792. Already imbued with the principles of the Revolution he turned against Paoli when the latter declared against France, and was spokesman of the deputation sent to Marseilles to solicit aid from the republic. He did not return to Corsica, as the whole Bonaparte family soon afterwards emigrated to France, and he obtained employment in the commissariat at Saint Maximin. Here he married Mlle. Christine Boyer, of poor but good family, and began to take the leading part in the popular meetings of the place. He was elected president of the Republican committee of the town, and, by his moderation and firmness, prevented excesses such as occurred in other parts of the country. After the fall of Robespierre he was in danger of being taken for one of his partisans, but resolutely maintained his ground, and declined to take refuge in flight. In 1795 he left Saint Maximin for Saint Chamans, where he had been appointed inspector of military stores, and where he was arrested and confined for six months. His release was obtained through his brother's influence with Barras, and he retired for a time to Marseilles. In 1795 he was made commissary to the army of the north, and spent some time at Brussels and in Holland; but his heart was in the political warfare of Paris, and in 1796 he obtained permission to resign. He had a short interview with Napoleon in Italy, and spent the two succeeding years in Corsica. In 1798 he was elected deputy to the Council of Five Hundred, and at once set off for Paris. He was an ardent adherent of the constitution of 1795 (the year III.), and sympathized rather with the Abbé Sieyès than with the extreme party. His abilities were soon recognized: he was an able and powerful speaker, with a calm courage that defied all popular tumult. His house, also, was the resort of the best literary society of Paris. It gradually became clear to him that the power of the Directory was divided and broken, and that a *coup d'état* was required to prevent another sanguinary revolution. There was but one man in a position to effect this change—his brother Napoleon, whose unexpected arrival on the 10th October 1799 was received with the utmost joy. A week after, Lucien was elected president of the Council of Five Hundred. Careful preparations were made, and on the 19th Brumaire the principles of the Revolution ceased to have a living power. On that day the coolness, promptitude, and courage of Lucien alone preserved Napoleon from destruction. He took part in preparing the new scheme of government, and was appointed to succeed La Place as minister of the interior. His competency for the post was undoubted, but differences with his brother had already begun, and these were fomented by the treacherous Fouché; so that, in little more than a year, he gave up office, and was sent as ambassador to Spain. He succeeded in his negotiations, though not entirely to Napoleon's satisfaction, and after his return to Paris took an active part in the arrangement of the Concordat and the establishment of a legion of honour. After the consulate had been settled on Napoleon for life Lucien was made a senator, and received the estate of Seppelsdorf. But his marriage in 1803 with the beautiful Mme. Jouberthon was displeasing to the First Consul, who already contemplated royal alliances for his brothers. Lucien, who did not approve the project of making the consulate hereditary, thought it advisable to leave France, and settled first at Milan, but finally at Rome. He lived in great magnificence, indulging his literary tastes, and apparently indifferent to the growth of the imperial power. After the peace of Tilsit Napoleon had an interview with him, and offered him a kingdom provided he would look upon it as in all respects a province of the empire. Lucien refused, and his brother then gave him to understand that he must quit the Continent. He withdrew from Rome, and settled on the estate of Canino, whence he took his title of prince, but soon came to the resolution of sailing for America. He embarked on the 1st August 1810, was captured by an English cruiser, and was carried to England, where for some time he was kept under surveillance in Ludlow Castle. He afterwards purchased a house near London, in which he resided till 1814, when he returned to Rome. In two letters to Elba he offered assistance to his brother; and during the Hundred Days he sat in the Chamber of Peers as a French prince. After Waterloo he advised Napoleon to dissolve the assemblies and proclaim himself dictator, and it was on his recommendation that the second abdication was made in favour of Napoleon's son. All his efforts to obtain a

regency were unavailing, and soon after parting from his brother on the 29th June, he left France. Arrested at Turin he was kept for three months in confinement before he was suffered to settle again at Rome. He passed the remainder of his life in Italy, surrounded by his family and busily engaged in literary and antiquarian labours. The grounds around Canino proved unusually rich in gems and Etruscan curiosities, of which a valuable cabinet was formed. He died at Viterbo, 29th June 1840 Lucien was a man of high abilities, resolute to his purpose, and of great courage and presence of mind He was throughout his whole life a moderate or constitutional republican. As a literary man he enjoys considerable distinction, though his great epic, *Charlemagne* (2 vols. 4to, London, 1814), was a failure. His *Mémoires*, unfortunately, have not been completed. He was twice married. By his first wife he had two daughters; by his second, four daughters and four sons. Of the sons the eldest, Charles Lucien Jules Laurent (born 1803, died 1857), prince of Canino, is distinguished as a naturalist, and takes rank along with Wilson and Audubon. In 1822 he married his cousin, Zenaide, daughter of Joseph Bonaparte, whom he joined in America. He remained there till 1828, and gained high reputation by his works on American ornithology. After his return to Italy he began the publication of a magnificent work, *Iconografia della Fauna Italica*, 3 vols., 1833–41. On his father's death in 1840 he succeeded to the title, and in 1847 began to interest himself in politics. He was ordered to leave the Austrian territories for having introduced political matter into a scientific congress, and in 1848–49 he took part on the Radical side in the disturbances at Rome. Driven from that city by the arrival of French troops he landed at Marseilles, but received an order to quit French territory. Not having paid any attention to this he was seized and conducted under escort to Havre, whence he was compelled to take ship for England. He returned once more to Paris, but did not again interfere in politics. Of the other sons of Lucien, Louis Lucien (born in 1813) has distinguished himself as a philologist, and is known by his writings on the Basque language as well as on the dialects of Italy and England; and Pierre Napoleon, commonly called Prince Pierre (born 1815), has lived a troubled life of adventure in Italy, America, and France. In January 1870 he shot and mortally wounded the journalist Victor Noir, who had called upon him to arrange preliminaries for a duel with M. Paschal Grousset. This unfortunate affair did inconceivable harm to the Napoleonic cause. The prince was found not guilty, but was ordered to indemnify the family of Noir. From that time he took up his residence in London.

IV Marie Anne Elisa, born at Ajaccio on the 3d January 1777. She married in 1797 Felix Bacciochi, captain of infantry, who was poor but of good family. In 1805 Lucca and Piombino were erected into a principality for her, and she gave such proofs of administrative ability as to be named the Semiramis of Lucca. After the fall of Napoleon she lived for some time at Brunn, and latterly at Santo Andrea near Trieste, where she died in 1820.

V. Louis, the father of Napoleon III., was born at Ajaccio in 1778. He received the greater part of his military education at the school of Chalons, and accompanied his brother throughout the famous Italian campaigns. He distinguished himself in various engagements, particularly at the battle of Arcola, but manifested little enthusiasm for a military career. He took part in the Egyptian expedition, and was sent back from Cairo to report the state of affairs and solicit reinforcements. In 1802, with the greatest reluctance, for he was enamoured of another, he was prevailed on to marry Hortense Beauharnais, Josephine's daughter. The forced marriage proved exceedingly unhappy. After the consulate he became general, and in 1804 was raised to the dignity of prince. He was commissioned to organize the army of the north in 1805, and performed his task to the complete satisfaction of Napoleon. Soon afterwards the States-general of Holland sent a deputation to the emperor praying that one of his brothers might be made their king. Louis, who was selected for this dignity, consented with considerable reluctance, and was proclaimed on the 6th June 1806. But when he had assumed the reins of government he manifested the warmest interest in his new subjects. He procured the withdrawal of the French troops from Holland, and formed a cabinet consisting almost entirely of Dutch notables. The decree blockading the British Isles was extremely offensive to him in his new position, and he evaded it so far as possible. In 1807 the death of his eldest son caused him to withdraw for a time to the south of France, and on his return Hortense did not accompany him. The relations of the king with Napoleon were anything but satisfactory. The emperor complained of not receiving due assistance from Holland, and in 1809 sent Bernadotte to take command of the army in that country. At the meeting of the two brothers in December 1809 there was a bitter quarrel; and Louis, who felt that his country was looked on as merely a province of the empire, was detained as a prisoner, while Holland was overrun with French troops. Before obtaining his release he was compelled to sign a new treaty with the emperor, which greatly curtailed his power. Matters were not improved after his return to Amsterdam, and on the 1st July 1810 he abdicated at Haarlem in favour of his elder son Napoleon Louis. He then set out for Töplitz, where he resided with the assumed title of Comte de St Leu. His kingdom was soon united to the empire, and no attention was paid to the arrangement he had made. After the Russian campaign he offered his services to his brother, and tried again, but in vain, to resume his power in Holland. In 1815 he instituted proceedings against his wife to obtain from her the custody of his elder son, and gained his cause. He refused to take any part in the Hundred Days, and settled in Rome, where he passed most of the remainder of his life. His wife was reunited to him, but the death of his elder son, in 1831, was a blow from which he never recovered. The unfortunate attempts of Louis Napoleon at Strasburg and Boulogne also affected him deeply; and he in vain attempted to procure his son's liberation from the prison of Ham. After the escape of the prince his father earnestly desired to see him, but passports for Italy could not be granted. The disappointment was too much for Louis, who was seized with apoplexy, and died on the 25th July 1846. His remains were conveyed to Saint Leu in 1847. Louis was of a somewhat retiring and philosophic disposition, inclined

fond of art, and liberal. In 1810 Napoleon, although he had a great affection for her, banished her from court for her insulting behaviour to Maria Louisa. Yet she joined him in the Isle of Elba in 1814, and would fain have accompanied him in his exile at St Helena. She was reconciled to her husband shortly before her death on 9th June 1825 Pauline was Napoleon's favourite sister. She was extremely beautiful, and her statue as Venus Victrix, by Canova, is a well-known work of art.

VII. Marie Annonciade Caroline, born at Ajaccio 1782. In 1800 she was married to Murat; in 1806 she became grand-duchess of Berg and of Cleves, and in 1808 queen of Naples. In 1815, after the flight of her husband, she was compelled to leave the capital, and surrendered to the Austrians. She was for a short time imprisoned at Trieste, and was then permitted to reside at Haimburg near Vienna. She afterwards obtained leave to take up her abode at Trieste with her sister Elisa. In 1838 she obtained a pension from the French Government, but did not enjoy it long. She died on 18th May 1839.

VIII. Jérôme, the youngest brother of Napoleon, was born at Ajaccio in 1784. In 1800 he entered the navy, and served in the Mediterranean, and under Villaret Joyeuse in the West Indies. In 1802–3 he was recalled; but tne port in which his vessel lay being blockaded by the English cruisers, he made his way to Boston, whence he intended to take a passage to France. He was well received in the United States, and fell violently in love with a beautiful young American, Miss Elizabeth Paterson, daughter of a Baltimore merchant, whom he married on the 24th December 1803. He remained in America till 1805. Meanwhile Napoleon, excessively displeased, had passed a decree annulling the marriage, and declined to allow the lady to enter France Jérôme's submission was rewarded by high command in the navy, in which he showed himself a competent officer. In 1806 he was made brigadier-general in the army, and distinguished himself in Silesia. On the 8th July of the following year he was made king of Westphalia; and, on the 22d August, he married the daughter of Frederick king of Würtemberg. He accompanied Napoleon on the Russian campaign, but was disgraced for apparent want of success in some engagement, and retired to his kingdom. After the first abdication he lived for some time at Trieste, but at once rejoined the emperor in 1815, and took a conspicuous part in the hurried events of the Hundred Days. After Waterloo and the second abdication, Jérôme retired to the kingdom of his father-in-law, where he lived in a species of imprisonment. He moved afterwards to Trieste, Rome, Florence, and Lausanne, and in 1847 was permitted to visit Paris. In the following year he was made governor of the Invalides, and in 1850 marshal of France. In 1852 he was president of the senate, but after that time he took no active part in politics. He died on the 24th June 1860. Of his children the only one famous is Joseph Charles Paul, commonly known as Prince Napoleon, born in 1822.

Besides the vast mass of *mémoires* and treatises relating to the Bonaparte family, the following special works may be noted:—A. du Casse, *Mémoires et correspondance politique et militaire du Roi Joseph*, 10 vols., 1854; Miot de Melito, *Mémoires*, 3 vols., 1858; *Mémoires de Lucien Bonaparte*, 1836, 1845; *Documents historiques et réflexions sur le Gouvernement de la Hollande* (by Louis), 3 vols. 1820; Du Casse, *Mémoires du roi Jerôme*; Wouter's *Les Bonapartes depuis 1815 jusqu'à nos jours*; Jerrold, *Life of Napoleon III.*, vol. i.

BONAVENTURA. John of Fidanza, or Fidenza, more commonly known as St Bonaventura, was born at Bagnarea in the Papal States, in the year 1221. He was at an early age destined by his mother for the church, and is said to have received his cognomen of Bonaventura from St Francis of Assisi, who performed on him a miraculous cure. He entered the Franciscan order in his twenty-second year, and is said to have studied at Paris under Alexander of Hales. This does not seem very probable, but he certainly studied under Alexander's successor, John of Rochelle, to whose chair he succeeded in 1253. Three years before that period his fame had gained for him permission to read upon the *Sentences*, and in 1255 he received the degree of doctor. So high was his reputation both for brilliancy of intellect and purity of mind that, in the following year, he was elected general of his order. He at once set himself to work to introduce better discipline, and by his mild regulations succeeded in effecting much good. He was an advocate of asceticism, and looked upon the monastic life as the surest means of grace. It is worthy of notice that by his orders Roger Bacon was interdicted from lecturing at Oxford, and compelled to put himself under the surveillance of the order at Paris. Bonaventura was instrumental in procuring the election of Gregory X., who rewarded him with the titles of cardinal and bishop of Albano, and insisted on his presence at the great Council of Lyons in the year 1274. At this meeting he died. Bonaventura's character seems not unworthy of the eulogistic title, "Doctor Seraphicus," bestowed on him by his contemporaries, nor of the place assigned to him by Dante in his *Paradiso*. He was formally canonized in 1482 by Sixtus IV.

His works, as arranged in the Lyons editon (7 vols., folio), consist of expositions and sermons, filling the first three volumes; of a commentary on the *Sentences* of Lombardus, in two volumes, celebrated among mediæval theologians as incomparably the best exposition of the third part; and of minor treatises filling the remaining two volumes, and including a life of St Francis. The smaller works are the most important, and of them the best are the famous *Itinerarium Mentis ad Deum*, *Breviloquium*, *De Reductione Artium ad Theologiam*, *Soliloquium*, and *De septem itineribus æternitatis*, in which most of what is individual in his teaching is contained. In philosophy Bonaventura presents a marked contrast to his great contemporaries, Thomas Aquinas and Roger Bacon. While these may be taken as representing respectively physical science yet in its infancy, and Aristotelian scholasticism in its most perfect form, he brings before us the mystical and Platonizing mode of speculation which had already to some extent found expression in Hugo and Richard of St Victor, and in Bernard of Clairvaux. To him the purely intellectual element, though never absent, is of inferior interest when compared with the living power of the affections or the heart. He rejects the authority of Aristotle, to whose influence he ascribes much of the heretical tendency of the age, and some of whose cardinal doctrines—such as the eternity of the world—he combats vigorously. But the Platonism he received was Plato as understood by St Augustine, and as he had been handed down by the Alexandrian school and the authors of the mystical works passing under the name of Dionysius the Areopagite. Bonaventura accepts as Platonic the theory that ideas do not exist *in rerum natura*, but as thoughts of the divine mind, according to which actual things were formed; and this conception has no slight influence upon his philosophy. Like all the great scholastic doctors he starts with the discussion of the relations between reason and faith. All the sciences are but the handmaids of theology; reason can discover some of the moral truths which form the groundwork of the Christian system, but others it can only receive and apprehend through divine illumination. In order to obtain this illumination the soul must employ the proper means, which are prayer, the exercise of the virtues, whereby it is rendered fit to accept the divine light, and meditation which may rise even to ecstatic union with God. The supreme end of life is such union, union in contemplation or intellect

and in intense absorbing love; but it cannot be entirely reached in this life, and remains as a hope for futurity. The mind in contemplating God has three distinct aspects, stages, or grades,—the senses, giving empirical knowledge of what is without and discerning the traces (*vestigia*) of the divine in the world; the reason, which examines the soul itself, the image of the divine Being; and lastly, pure intellect (*intelligentia*) which, in a transcendent act, grasps the Being of the divine cause. To these three correspond the three kinds of theology,—*theologia symbolica, theologia propria*, and *theologia mystica*. Each stage is subdivided, for in contemplating the outer world we may use the senses or the imagination; we may rise to a knowledge of God *per vestigia* or *in vestigiis*. In the first case the three great properties of physical bodies—weight, number, measure,—in the second the division of created things into the classes of those that have merely physical existence, those that have life, and those that have thought, irresistibly lead us to conclude the power, wisdom, and goodness of the Triune God. So in the second stage, we may ascend to the knowledge of God, *per imaginem*, by reason, or *in imagine*, by the pure understanding (*intellectus*); in the one case the triple division—memory, understanding, and will,—in the other the Christian virtues—faith, hope, and charity—leading again to the conception of a Trinity of divine qualities—eternity, truth, and goodness. In the last stage we have first *intelligentia*, pure intellect, contemplating the essential being of God, and finding itself compelled by necessity of thought to hold absolute being as the first notion, for non-being cannot be conceived apart from being, of which it is but the privation. To this notion of absolute being, which is perfect and the greatest of all, objective existence must be ascribed. In its last and highest form of activity the mind rests in the contemplation of the infinite goodness of God, which is apprehended by means of the highest faculty, the *apex mentis*, or *synderesis*. This spark of the divine illumination is common to all forms of mysticism, but Bonaventura adds to it peculiarly Christian elements. The complete yielding up of mind and heart to God is unattainable without divine grace, and nothing renders us so fit to receive this gift as the meditative and ascetic life of the cloister. The monastic life is the best means of grace.

Bonaventura, however, is not merely a meditative thinker, whose works may form good manuals of devotion; he is a dogmatic theologian of high rank, and on all the disputed questions of scholastic thought, such as universals, matter, the principle of individualism, or the *intellectus agens*, he gives weighty and well-reasoned decisions. He agrees with Albert in regarding theology as a practical science; its truths, according to his view, are peculiarly adapted to influence the affections. He discusses very carefully the nature and meaning of the divine attributes; considers universals to be the ideal forms pre-existing in the divine mind according to which things were shaped; holds matter to be pure potentiality which receives individual being and determinateness from the formative power of God, acting according to the ideas; and finally maintains that the *intellectus agens* has no separate existence. On these and on many other points of scholastic philosophy the Seraphic Doctor exhibits a combination of subtilty and moderation which makes his works peculiarly valuable.

Editions of Bonaventura's works are numerous. The most complete early edition was that in 7 vols. fo., Rome, 1588-96. They have also been published at Lyons, 7 vols., 1668, and at Venice, 14 vols., 1751, *sqq*. The best edition is that by A. C. Peltier, begun in 1863. Of detached works the editions and translations are very numerous. The following are perhaps the most important:—*Breviloquium et Itinerarium Mentis ad Deum*, ed. Hefele, 3d ed., 1862; *Théologie Séraphique, extraite et traduite des œuvres de St B.*, by Alix, 2 vols., 1853-56. For Bonaventura's philosophy, see Erdmann, Hauréau, Stöckl; the works on the history of mysticism by Schmid, Görres, Helfferich, Noack, and Preger; and Ozanam, *Dante et la Philosophie Catholique au XIIIme Siècle*. There are two monographs on him,—Margerie (A. de), *Essai sur la philosophie de St Bonaventure*, 1855, and Hollenberg, *Studien zu Bonaventura*, 1862. Notices of his life are given in the Venice edition, and in that of Peltier; also in the *Histoire Litt. de la France*, vol. xix. (R. AD.)

BONDU, a kingdom of Western Africa lying to the W. of Bambouk, from which it is separated by the River Faleme, between 14° and 15° N. lat., and 12° and 13° W. long. The country is an elevated plateau, with hills in the southern and central parts. These are generally unproductive, and covered with stunted wood; but the lower country is fertile, and finely clothed with the baobab, the tamarind, and various valuable fruit-trees. It is traversed by beds of torrents, which flow rapidly during the rains, but are empty in the dry season. Cultivation, though it extends over only a comparatively small proportion of the whole surface, is carried on with a measure of activity. The products consist of grain (four species), rice, cotton, indigo, water-melons, cucumbers, tobacco, and fruits. The workmen in the different parts display considerable dexterity, though they employ very rude and defective tools. The people consist chiefly of Foulahs, though the country is much frequented by Mandingoes and Serawoollies for purposes of trade. The exports consist of provisions and cotton cloth manufactured in the country, and slaves and salt are imported. The caravans, bringing the former from the interior to the coast, pass usually through Bondu. The religion and laws of this country are Mahometan, though the precepts of that faith are not very rigorously observed. There are schools, however, in every town, where the Koran and the reading and writing of Arabic are taught; but the scholar is treated as the menial servant of the teacher. The king is nearly absolute, and commands a considerable body of troops, who are much employed in predatory expeditions, chiefly for the purpose of collecting slaves. His revenues are derived from a tenth part of the produce of the land, and of the salt imported, as also from duties on goods passing through his territories, with numerous presents expected or extorted. Park, who was the first European traveller to visit the country, experienced to his cost the rapacity of the reigning prince, being obliged to give up even the coat which he wore. The royal residence was then at Fatteconda; but when Major Gray visited Bondu it had been removed to Bulibani, a small town, with about 3000 of a population, surrounded by a strong clay wall. The population of the whole country is estimated at 1,500,000.

BÔNE, BONA, BOUNAH, BELED-EL-A'NEB (*the town of jujubes*), or ANNABA, a fortified town and seaport of Algeria, in the province of Constantine, 85 miles N.E. of the city of that name, on a bay of the same name at the mouth of the Seybouse, in lat. 36° 54′ N. and long. 7° 47′ E. The town is surrounded with a modern rampart erected outside of the old Arab wall, the compass of which was found too small for its growth. In other respects also it has been greatly Europeanized; much of the old town has been demolished, and the ground occupied by new buildings. The streets are wide and well laid out, but in some instances are very steep, owing to the formation of the ground. All the ordinary conveniences of a flourishing French city are met with,—bazaars, markets, coffee-houses, hotels, reading-rooms, a bank, a theatre, barracks, hospitals, an orphan asylum, and schools of various kinds. There is also a cathedral dedicated to St Augustine, as well as other Roman Catholic churches, a nunnery for sisters of mercy, handsome mosques, a synagogue, and a Protestant church. Bône is an important seat of the coral fishery, and carries on a considerable trade, the exports consisting chiefly of iron and lead ore, corn, coral, cattle and sheep, olive oil, salt fish, and tobacco. The manufactures comprise native garments,

tapestry, leather, and saddles, and of late its soap has come into repute. In 1872 there entered the port 461 French vessels, with a tonnage of 187,415 tons, and 506 foreign ships with a tonnage of 40,822. The anchorage was long insecure; but about 1870 a harbour, with an area of 195 acres, was constructed by means of two breakwaters, and an inner basin, surrounded with masonry quays, and having an extent of nearly 25 acres. The marshes at the mouth of the river have also been drained by a system of canals, to the great improvement of the sanitary condition of the town, which has the further advantage of an abundant supply of water obtained from the neighbouring hills. There are cork-woods and marble-quarries in the vicinity, and various other resources of the surrounding country are being rapidly developed. The woods, however, suffered severely from a conflagration in 1873; and it will be many years before the production of cork can become as extensive as before. The port will be rendered still more important by the railway in course of construction to various inland towns. Bône is identified with the ancient *Aphrodisium*, the seaport of *Hippo Regius* or *Ubbo*, but it derives its name from the latter city, the ruins of which, consisting principally of large cisterns, and part of the Roman walls, are still to be found about a mile to the south of the town. Hippo, the bishopric of Augustine, was burnt by the Vandals in 430, partially restored by Belisarius, and again sacked by the Arabs in the 7th century. The latter conquerors built the city of Bona, or Annaba, which has since passed through many vicissitudes. From the beginning of the 14th to the middle of the 15th century it was frequented by Italians and Spaniards, and in the 16th it was held for some time by Charles V., who strengthened its *Casbah* or citadel, originally built in 1300. From the time of Louis XIV. to the Revolution the French *Compagnie d'Afrique* maintained a very active trade with the port. The town was finally captured by the French in 1832, and its citadel was defended by a small body of marines for some months against the Turks. Population in 1872, 16,196, about half of whom are European; in 1832 it was only 3000 or 4000.

BONE, HENRY, R.A., the most eminent enamel painter of his time in Great Britain, was born at Truro in 1755. He was much employed by London jewellers for small designs in enamel, before his merits as an artist were well known to the public. In 1800 the beauty of his pieces attracted the notice of the Royal Academy, of which he was then admitted as an associate; in 1811 he was made an academician. From the beginning of the century to 1831, he executed many beautiful pieces of much larger size than had been attempted before in England; among these his eighty-five portraits of the time of Queen Elizabeth, of different sizes, from 5 by 4 to 13 by 8 inches, are most admired. They were disposed of by public sale after his death, which took place in 1834. His Bacchus and Ariadne, after Titian, painted on a plate, brought the great price of 2200 guineas.

BONFIGLI, BENEDETTO, an Italian painter, whose reputation is not equal to his importance. One of the most remarkable circumstances in the history of art in the peninsula is the sudden advance made by the school of the Umbrian province, which, until near the middle of the 15th century, was far behind those of Florence and the North, but which, in the person of Perugino and some of his followers, came into the very first rank. Criticism had been used to overlook the precursors and senior companions of Perugino, whose improvements prepared the way for his signal excellences. But among these none holds a more distinguished place than Benedetto Bonfigli. The most important of his extant works are a series, in fresco, of the life of St Louis of Toulouse, in the communal palace of his native city of Perugia. All his life (the dates of which are not quite certain) was spent in honourable employment by the civic and religious bodies of Perugia and neighbouring towns.

BONGO, a people of Central Africa, who inhabit the country lying between 6° and 8° N. lat., and 27° and 29° E. long., which is watered by five important tributaries of the Bahr-el-Ghazel. The Bongo are a brachycephalous race of medium height, with a red-brown complexion and black hair. The grain most largely cultivated by them is sorghum; but they obtain a considerable part of their food from the fruits, tubers, and fungi with which the country naturally abounds. They also eat every living creature—bird, beast, and reptile—except the dog. Tobacco is universally cultivated and smoked. They have no cotton or flax, and go for the most part with no more clothing than an ornamental girdle about the loins. The domestic animals are goats, dogs, and poultry; sheep and cattle are rare. Iron is abundant, and the people smelt and work it with great skill; it forms the only currency of the country, and is extensively employed for all kinds of useful and ornamental purposes. Their spears, knives, rings, and other articles are frequently fashioned with great artistic elaboration. They have a variety of musical instruments,—drums, stringed instruments, and horns,—in the practice of which they take great delight; and they indulge in a vocal recitative which seems intended to imitate a succession of natural sounds. Marriage is generally by purchase; and a man is allowed to acquire three wives, but not more. After marriage the women extend the under lip by the insertion of a peg of wood or bone, which is gradually increased. Tattooing is partially practised. Their method of sepulture resembles that of the Peruvians, the corpse being bound in a crouching position with the knees drawn up to the chin; and their tombs are frequently ornamented with rough wooden figures intended to represent the deceased. Of the immortality of the soul they have no notion; and their only approach to a knowledge of a deity consists in a vague idea of luck. On the other hand they have a most intense belief in a great variety of petty goblins and witches, which are identified with bats, owls, and other ominous animals. Their language is musical, and abounds in the vowels *o* and *a*; its vocabulary of concrete terms is very rich, but the same word has often great variety of meanings. The grammatical structure is simple. The Bongo are now subject to the people of Khartoom, who have treated them with great injustice, and greatly reduced the numbers of the population, which now hardly exceeds 100,000.

BONI, a kingdom or confederation in the island of Celebes, stretching along a part of the western shores of a great bay of the same name, which indents the south side of the island to the depth of nearly 180 miles. It has an area of 450 square miles at most, and its present population is estimated about 200,000. It was at one time the most powerful state of Celebes, all the other princes being regarded as vassals of its king, but has latterly been practically reduced to a Dutch dependency, though this has not been brought about without trouble. An expedition in 1825, under General van Geen, was not very successful; but the war of 1859 was brought to a more satisfactory termination for the invaders. The inhabitants, called Bugis, are one of the most remarkable of the peoples of the Eastern Archipelago. They speak a language allied to that of the Macassars, and write it with similar characters. It has been studied and its letters reproduced in type by Dr B. F. Matthes of the Netherlands Bible Society. The Bugis are industrious and ingenious; they practise agriculture more extensively than the neighbouring tribes, and manufacture cotton cloth not only for their own use, but also

for export. They likewise carry on a considerable traffic in the mineral and vegetable productions of their country, such as gold dust, tortoise-shell, pearls, nutmegs, camphor, and various medicinal preparations. Their towns are regularly built, and they have schools of their own. The king is elected generally for life, and always from their own number, by the chiefs of the eight petty states that compose the confederation, and he cannot decide upon any public measure without their consent. In some of the states the office of chief is hereditary; in others any member of the privileged classes may aspire to the dignity, and it not unfrequently happens that the state comes to be governed by a woman. The capital, also called Boni, is situated on the coast in 4° 37′ S. lat. and 120° 30′ E. long., and is the residence of the king. Various Dutch settlements have been formed round the bay. Of the history of Boni not much is known. According to Temminck, it first acquired importance in the year 1666, when the rajah Palakkah, whose father and grandfather had been murdered by the family of Hassan, the tyrant of Sumatra, made common cause with the Dutch against that despot. From that date till the beginning of the present century the Dutch influence in the kingdom remained undisputed. In 1814, however, Boni fell into the hands of the British, who retained it for two years; but by the European treaties concluded on the downfall of Napoleon it reverted to its original colonizers. See CELEBES.

BONIFACE, ST, the Apostle of Germany, whose real name was Winfrid, was born at Crediton in Devonshire, in 680. He was of good family, and it was somewhat against his father's wishes that he devoted himself at an early age to the monastic life. He received his theological training in the convents of Exeter and Nutcell, and at the age of thirty became a priest. In 715 he set out on a missionary expedition to Friesland, but his efforts were frustrated by the war then being carried on between Charles Martel and Radbod, king of the Frisians. Despite the wishes of his brethren, who desired to make him their abbot, he again set out in 718, visited Rome, and was commissioned by Gregory II. to preach to the pagans of Germany. For five years he laboured in Thuringia, Hessia, and Friesland, and then returned to Rome to report his success. He again set out for Germany, and, armed with full powers from the Pope, baptized thousands of the heathen, and brought back to the Church of Rome many Christians who had in a measure separated themselves from the fold. After another visit to Rome in 738 he proceeded to Bavaria, and founded there the bishoprics of Salzburg, Regensburg (Ratisbon), Freisingen, and Passau. He then resumed his labours in Germany, where he erected the districts of Würzburg, Erfurt, and Burburg into bishoprics. He also organized provincial synods in the Frankish Church, and obtained great influence over the king, Pepin, whom he crowned at Soissons. Boniface had been created a bishop by Gregory II., and after the deposition of the bishop of Mainz in 745, that bishopric was converted into a metropolis and conferred upon him, much against his own inclinations. He had never relinquished his hope of converting the Frisians, and in 755 he set out with a small retinue for Friesland. He baptized a great number, and summoned a general meeting for confirmation at a place not far from Dokkum, between Franeker and Groningen. Instead of his converts, however, there appeared a mob of armed pagans, who fell upon the aged archbishop and slew him. His remains were finally deposited in the famous abbey of Fulda, founded by himself.

The epistles of Boniface have been published by Serrarius, 1605, and by Würdtwein, 1790; his works by Giles, 2 vols., 1842. On his life and labours see Löffler, *Bonifacius*, 1812; Seiter, *Bonifacius*, 1845; Rettberg, *Kirchengeschichte Deutschlands*, i.; Neander, *Church History*, Bohn's transl., vol. v.

BONIFACE, the name of nine popes.

BONIFACE I., bishop of Rome from 418 to 422, was a contemporary of St Augustine, who dedicated to him some of his works.

BONIFACE II., 530–532, was by birth a Goth, and owed his election to the influence of the Gothic king. He had for some time an anti-pope, Dioscurus.

BONIFACE III., 15th February to 12th November 606, obtained from Phocas recognition of the headship of the Church at Rome.

BONIFACE IV., 608–615, received from Phocas the Pantheon at Rome, which was converted into a Christian church.

BONIFACE V., 619–625, did much for the Christianizing of England.

BONIFACE VI. was elected in April 897, and died fifteen days afterwards.

BONIFACE VII., who attained the Papal chair in 974, is sometimes styled an anti-pope. He is supposed to have put his predecessor, Benedict VI., to death. A popular tumult compelled him to flee to Constantinople; but he carried with him vast treasure, and in 984 he returned and removed, by murder, John XIV., who had been elected in his room. He died in 985 or 986.

BONIFACE VIII., Benedict Cajetan, a man of great ability, was elected in 1294, Celestine V. having been persuaded to resign. He meddled incessantly in foreign affairs, and put forward the strongest claims to temporal as well as spiritual supremacy. His bitterest quarrels were with the emperor, with the powerful family of the Colonnas, and with Philip the Fair of France, whom he excommunicated in 1303. He was about to lay all France under an interdict when he was seized at Agnani by a party of horsemen under Nogaret, an agent of Philip, and Sciarra Colonna. After three days' captivity he was rescued by the town's people, but the agitation he had undergone caused his death soon after, on the 11th October 1303. In 1300 Boniface instituted the *jubilees*, which afterwards became such a source of profit and of scandal to the church.

BONIFACE IX. was elected in 1390 and died in 1404. During his time the so-called Clement V. continued to hold state as pope in Avignon.

BONIFACIO, a town at the southern extremity of Corsica, in the arrondissement of Sartene, near the strait to which it gives its name. It is one of the most picturesque and interesting places in the island, its white houses being built on the top of a white calcareous rock that can only be reached on foot or on horseback. It is well fortified, has a secure harbour, carries on some trade, and has coral fisheries. The rock is hollowed out into vast caves that stretch below the town. Bonifacio was founded in 833 by the Tuscan Marquis whose name it bears, as a defence against the Saracen pirates. At the end of the 11th century it became subject to Pisa, and in 1195 was taken by the Genoese, whose influence continues to affect the character of the population to this day. In 1421 it heroically withstood a protracted siege by Alphonso of Aragon; but in 1553 it fell into the hands of the Franco-Turkish army. Population in 1872, 3402. (See Gregorovius's *Corsica*, vol. ii.; Lear, *Journ. in Corsica*, p. 62.)

BONN, the chief town of a circle of Rhenish Prussia, situated on the left bank of the Rhine, about 16 miles by rail S.S.E. of Cologne. The central part is mostly composed of very narrow streets, but the outskirts contain numerous fine buildings, and the general appearance from the river is rather attractive. There are five Roman Catholic and two Protestant churches, the most important of which is the Minster or St Cassius, an old building in

the Transition style, surmounted by five towers. The town also possesses a "Rathhaus," of modern erection, a court-house, a hospital, a gymnasium, and a theatre. By far the finest of its buildings, however, is its famous university, which occupies the larger part of the southern frontage of the town. The present establishment only dates from 1818, and owes its existence to the king of Prussia; but as early as 1786 the academy which had been founded about nine years before was raised by Archbishop Maximilian Frederick of Cologne to the rank of a university, and continued to exercise its functions till 1794, when it was dissolved by the last elector. The building now occupied was originally the electoral palace, constructed about 1717 out of the materials of the old fortifications. It was remodelled after the town came into Prussian possession. There are five faculties in the university—a legal, a medical, and a philosophic, and one of Catholic and another of Protestant theology; in 1873 it was attended by 752 students, ranking as eighth among the German universities. The library numbers upwards of 200,000 volumes; and the antiquarian museum contains a valuable collection of Roman relics discovered in the neighbourhood. A separate building for anatomical operations is situated in the extensive garden to the south of the university; and an academy of agriculture, with a natural history museum and botanic garden attached, is established in the palace of Clemensruhe at Poppelsdorf, which is reached by a fine avenue about a mile long, bordered on both sides by a double row of chestnut trees. A splendid observatory, long under the charge of Argelander, stands on the south side of the road. Among the numerous men of learning who have taught or teach in Bonn are the theologians Bleek and Lange, Hermes and Achterfeldt; the jurists Walter and Böcking; Harless, Mayer, and Rindfleisch in the medical faculty; and Niebuhr, Welcker, Ritschl, Brandis, Lassen, Simrock, Diez, and Sybel, in various branches of literature and history. Beethoven was born in the town, and a statue was erected to him in the Münsterplatz in 1845. Niebuhr is buried in the cemetery outside of the Sternthor, where a monument was placed to his memory by Frederick William IV. But for its university Bonn would be a place of comparatively little importance, its industry and commerce being of moderate dimensions. Its principal manufactures are cotton and silk, earthenware, soap, vitriol, and tobacco; and its trade, chiefly carried on by the Rhine, consists largely of corn and wine. Population in 1871, 26,030. Bonn (*Bonna* or *Castra Bonnensia*), originally a town of the Ubii, became at an early period the site of a Roman military settlement, and as such is frequently mentioned by Tacitus. It was the scene, in 70 A.D., of a battle, in which the Romans were defeated by Claudius Civilis, the valiant leader of the Batavians. Greatly reduced by successive barbarian inroads it was restored about 359 by the Emperor Julian, but its importance only dates from 1268, when it became the residence of the electors of Cologne. During the various wars that devastated Germany in the 16th, 17th, and 18th centuries, the town was frequently besieged and occupied by the several belligerents, but continued to belong to the electors till 1794, when the French took possession of it. At the peace of Lunéville they were formally recognized in their occupation; but by the Vienna Congress of 1814 the town was made over to Prussia. The fortifications had been dismantled in 1717.

BONNER, or BONER, EDMUND, an English prelate, notorious for his persecutions of the Protestants during the reign of Queen Mary, was born at Hanley in Worcestershire, about the end of the 15th century, and generally passed for the natural son of George Savage, a priest who was the natural son of Sir John Savage of Clifton in the same county. Strype in his *Memorials of Cranmer*, however, says he was positively assured that Bonner was the legitimate offspring of a poor man, who lived in a cottage long afterwards known as Boner's place. About 1512 he entered as a student of Broadgate Hall (now Pembroke College), Oxford; and in 1519 he was admitted as bachelor of the canon and of the civil law. Having been admitted into orders, he obtained some preferment in the diocese of Worcester. In 1525 he took his degree as doctor, and attracted the notice and patronage of Wolsey. Bonner was with the cardinal at Cawood when he was arrested on charge of high treason. After the death of Wolsey he adopted Lutheran sentiments, and insinuated himself into the favour of Henry VIII., who made him one of his chaplains, and employed him in several embassies abroad. In 1532 he was sent to Rome with Sir Edward Carne, to answer for the king, who had been cited to appear in person or by proxy in regard to the divorce of Queen Catharine. In 1533, being again despatched to Pope Clement VII., then at Marseilles, to intimate Henry's appeal to a future general council from the sentence pronounced against his divorce, he threatened the Pope with so much resolution, that his holiness talked of having him burned alive or thrown into a cauldron of melted lead. Clement did not foresee that the man whom he had thus menaced with the flames was destined to burn heretics in England in support of the very faith which, under Henry, he had lent his aid to overthrow. In 1538, being then ambassador at the court of France, he was nominated bishop of Hereford; but before consecration, he was translated to the see of London, and was enthroned in April 1540. When Henry VIII. died in 1547, Bonner was ambassador at the court of the Emperor Charles V. During Henry's reign he was constantly zealous in his opposition to the Pope, and favoured the Reformation in obedience to the king, who exacted rigid compliance with all his caprices. On the accession of Edward, however, Bonner refused to take the oath of supremacy, and was committed to the Fleet, where he remained until he promised obedience to the laws. After his release he assented to the Reformation, but with such manifest reluctance, that he was twice reprimanded by the Privy Council, and in 1549 was, after a long trial, committed to the Marshalsea, and deprived of his bishopric, to which, however, he was restored on the accession of Mary; and soon afterwards he was appointed, in place of Cranmer, vicegerent and president of the Convocation. From this time he became the chief instrument of persecution, and is said to have condemned no less than 200 Protestants to the flames in the space of three years. On the accession of Elizabeth he appeared with the rest of the bishops at Highgate, to congratulate her; but the queen refused to permit him to kiss her hand. Having, in the second year of her reign, refused to take the oath of supremacy, he was again committed to the Marshalsea, where he died, September 5, 1569, after a confinement of ten years. The character of Bonner was remarkable for obstinacy and inflexibility in everything save principle; yet even in this respect it exhibits some striking contrasts. In his early career he accommodated his principles to his convenience and ambition; after his return to Catholicism, he remained steadfast to the church, and, when disgraced, bore his deprivation and imprisonment with apparent resignation. The charge of atheism brought against one so defiled with blood was superfluous. He was constitutionally merciless and austere, fitted by nature for a persecutor, and equally capable of employing the same ardent zeal either against or in favour of any cause that he espoused. Among his works are, *Responsum et Exhortatio in Laudem Sacerdotii*,

a preface in Gardener's treatise *De Vera Obedientia*, and several homilies.

BONNET, Charles, an eminent naturalist and philosophical writer, was born at Geneva on the 13th March 1720. The Bonnets, a French family whom the religious persecution in the 16th century had driven into Switzerland, were accustomed to fill important posts in the Genevese Government; and young Charles Bonnet was expected to qualify himself to make use of the family influence by becoming a lawyer. But dry legal technicalities proved to be anything but attractive to his rich and imaginative mind, all the more that he found in the study of nature an employment which was not also a task. He made law his profession, but he never seems to have permitted it to interfere seriously with his favourite pursuits. The account of the ant-lion in Pluche's *Spectacle de la Nature*, which he chanced to read in his sixteenth year, turned his attention in particular to the wonders of insect life. He procured Réaumur's work on insects, and with the help of live specimens succeeded, after minute and patient investigation, in adding many observations to those of Réaumur and Pluche. The result of two years' labour he made known to Réaumur, who was naturally not a little surprised to find so much sagacity and power of research in a youth of eighteen. In 1740 Bonnet communicated to the Academy of Sciences a paper containing a series of experiments establishing what is now termed parthenogenesis in *aphides* or tree-lice, which obtained for him the honour of being admitted a corresponding member of the academy. In 1741 he instituted a set of experiments respecting the reproduction of worms by fission; and in the following year he discovered that the respiration of caterpillars and butterflies is performed by pores, to which the name of *stigmata* has since been given. In 1743 he was admitted a fellow of the Royal Society; and in the same year he became a doctor of laws,—his last act in connection with a profession which had ever been distasteful to him. His first published work appeared in 1745, entitled *Traité d'Insectologie*, in which were collected his various discoveries regarding insects, along with a preface on the development of germs and the scale of organized beings. Botany, particularly the leaves of plants, next attracted the attention of Bonnet; and after several years of diligent study, rendered irksome by the increasing weakness of his eyesight, he published, in 1754 one of the most original and interesting of his works, *Traité de l'usage des feuilles*; in which among other things he advances many considerations tending to show that plants are endowed with powers of sensation and discernment. But Bonnet's eyesight, which threatened to fail altogether, now caused him to turn his thoughts from investigation to speculation. In 1754 his *Essai de Psychologie* was published anonymously in London. This was followed in 1760 by the *Essai analytique sur les facultés de l'âme*, in which he develops his views regarding the physiological conditions of mental activity. He returned to physical science, but to the speculative side of it, in his *Considérations sur les corps organisés*, Amsterdam, 1762. The principal objects of this work were to give, in an abridged form, all the most interesting and well-ascertained facts respecting the origin, development, and reproduction of organized bodies, to refute the theory of *epigenesis*, and to explain and defend the doctrine of pre-existent germs. In his *Contemplation de la Nature*, which next appeared (1764–5), one of his most popular and delightful works, he sets forth, in eloquent language, the theory that all the beings in nature form a gradual scale rising from lowest to highest, without any break in its continuity. His last important work is entitled *Palingénésie Philosophique*, (Geneva, 1769); in it he treats of the past and future of living beings, and supports the idea of the survival of all animals, and the perfecting of their faculties in a future state. Bonnet's life was singularly uneventful. He seems never to have passed beyond the limits of his native country; nor does he appear to have taken any part in public affairs except for the comparatively short period between 1752 to 1768, during which he was a member of the council of the republic. The last twenty-five years of his life he spent in the country, simple and regular in his mode of life, easy in his circumstances, and happy in a small circle of friends. His wife, whom he married in 1756, was a lady of the family of De la Rive. They had no children, but Madame Bonnet's nephew, the celebrated De Saussure, was brought up as their son. Bonnet died, after a long and painful illness, on the 20th May 1793.

The outlines of Bonnet's philosophical system may be set forth in a few sentences. Man, according to him, is a mixed being, composed of two distinct substances,—mind and body,—the one immaterial and the other material. In what manner the two are connected we do not know, but of this at least we are certain, that bodily activity is a necessary condition of thought. All knowledge originates in sensations; sensations themselves follow (but whether as physical effects or merely as sequents Bonnet will not say) vibrations in the various nerves appropriate to each; and lastly, the nerves are made to vibrate by the action of outward objects upon them. A nerve once set in motion by a particular object contracts a certain tendency to reproduce that motion; so that when it a second time receives an impression from the same object it vibrates with less resistance. It is the sensation accompanying this increased flexibility in the nerve that is, according to Bonnet, the condition of memory. When reflection—that is, the active as distinguished from the merely passive element in mind—is applied to the acquisition and combination of sensations, those abstract ideas are formed which are usually placed in opposition to sensations, but which are thus, no matter how refined they may appear, sensations in combination only. That which puts the mind into activity is pleasure or pain; happiness is the end of human existence. Bonnet's metaphysical theory is based on two principles borrowed from Leibnitz,—first, that there are not successive acts of creation, but that the universe is completed by the original act of the divine will, and thereafter moves on by its own inherent force; and, secondly, that there is no gap in the continuity of existence. The divine Being, according to Bonnet, originally created a multitude of germs in a graduated scale, each with an inherent power of self-development. At every successive step in the progress of the globe, these germs, or what has been developed in their place, advance nearer to perfection; if some advanced and others did not there would be a gap in the continuity of the chain. Thus not man only but all other forms of existence are immortal. Nor is it man's mind merely; his body also will pass into the higher stage, not, indeed, the body he now possesses, but a finer one of which the germ at present exists within him. This is equally true of the other animals, who also possess a germ that will develop itself in the next stage; and every individual begins each successive stage with that amount of perfection and of knowledge which he had when he left the previous stage. It is impossible, however, to reach absolute perfection, because the distance is infinite. It is difficult to reconcile this last proposition with the law of continuity, if that law is to be accepted, as Bonnet seems to accept it, as an absolute principle of the universe, embracing all existence divine and created, for surely the interval between the divine Being and the highest created being, constantly lessening though it be, is a break in the continuity of the chain. It is also difficult to understand whether the constant advance to perfection is performed by every individual on his own account, or only by each race of beings as a

whole. Is a man when he dies at once translated to the next stage, or must he wait until the time comes when the advancement of the whole human race takes place, before he, at any rate consciously, realizes the new state? There seem, in fact, to be two distinct but somewhat analogous doctrines,—that of the constantly increasing advancement of the individual in future stages of existence, and that of the constantly increasing advancement of the race as a whole according to the successive evolutions of the globe.

Bonnet's complete works appeared at Neufchatel in 1779-1785, partly revised by himself. An English translation of certain portions of the *Palingénésie Philosophique* was published in 1787, under the title, *Philosophical and Critical Inquiries concerning Christianity*. (See A. Lemoine, *Charles Bonnet*, Paris, 1850; and the Duc de Caraman's *Charles Bonnet, philosophe et naturaliste*, Paris, 1859.)

BONNEVAL, Claude Alexandre, Comte de, a celebrated French adventurer, known also as Achmet Pasha, was the descendant of an old family of Limousin. He was born on the 14th July 1675 at Coussac, and at the age of thirteen joined the Royal Marine Corps. After three years he entered the Guards, whence he was transferred to the infantry regiment of Latour He served in the Italian campaigns under Catinat, Villeroi, and Vendôme, and in the Netherlands under Luxembourg, giving proofs of indomitable courage and great military ability. His insolent bearing towards Chamillard, minister of war, was made matter for a court-martial. He was condemned to death, but having foreseen this sentence, he saved himself by flight to Germany. Through the influence of Prince Eugene he obtained a command in the Austrian army, and fought with great bravery and distinction against France, and afterwards against Turkey. He was severely wounded at Peterwardein, and after his recovery paid a visit to Paris. The proceedings against him in France had been allowed to drop, and he married a daughter of Marshal de Biron, whom, however, he deserted after a week or two. He returned again to the Austrian army, and fought with distinction at Belgrade. He might now have risen to the highest rank, had he not made himself disagreeable to Prince Eugene, who sent him as master of the ordnance to the Low Countries There his ungovernable temper led him into a quarrel with the Marquis de Prié, governor of the Netherlands, who answered his challenge by placing him in confinement. A court-martial was again held upon him, and he was condemned to death; but the emperor commuted the sentence to one year's imprisonment and banishment from the imperial domains. Bonneval, soon after his release, offered his services to the Turkish Government, professed the Mahometan faith, and took the name of Achmet. He was made a pasha of three tails, and appointed to the command of the artillery. He rendered valuable sevices to the sultan in his war with Russia, and with the famous Kouli Khan. As a reward he received the governorship of Chios, but soon fell under the suspicion of the Porte, and was banished for a time to the shores of the Black Sea. He was meditating a return to Europe and Christianity when he died at Constantinople, 27th March 1747. The *Memoirs* published under his name are spurious. (See Prince de Ligne, *Mémoire sur la Comte de Bonneval*, 1817.)

prisoned for two years at Grolée. On his liberation he returned to his priory. In 1530, when travelling in the service of the republic, he was unfortunate enough to fall into the hands of robbers, who delivered him over once more to the duke of Savoy. His imprisonment in the castle of Chillon, which has been celebrated in Byron's poem, lasted till 1536, when he was liberated by the combined force of the Bernese and Genevese. On his return to Geneva, which had now completely emancipated itself, he received the honours and rewards that were due to his patriotism, being made a member of the Council of Two Hundred, and endowed with a pension. He died about 1570, the precise date being uncertain. Bonnivard was the author of a history of Geneva, and left his books and manuscripts to the town.

BONPLAND, Aimé, French traveller and botanist, was born at Rochelle, August 22, 1773. After serving as a surgeon in the French navy and studying under Corvisart at Paris, he accompanied Humboldt during five years of travel in Mexico, Colombia, and the districts bordering on the Orinoco and Amazon. In these explorations Bonpland collected and classified about 6000 plants till then mostly unknown in Europe, which he afterwards described in *Plantes Equinoxiales*, &c. (Paris, 1808-1816). On returning to Paris he received a pension and the superintendence of the gardens at Malmaison, became acquainted with Gay-Lussac, Arago, and other eminent scientists, and published *Monographie des Mélastomées* (1806), and *Description des plantes rares de Navarre*. After vainly endeavouring to persuade Napoleon to retire to America, he set out, in 1816, with various European plants for Buenos Ayres, where he was elected professor of natural history, an office which he soon quitted in order to explore Central South America. While journeying to Bolivia he was arrested as a spy, in 1821, by command of Dr Francia, who detained him a prisoner at Santa Marta until 1831, during which time he acted with great disinterestedness as a physician to the neighbouring poor. On regaining liberty he resided at San Borje in the province of Corrientes, until his removal in 1853 to Santa Anna, where he occupied himself in scientific research, and in cultivating the orange trees which he had introduced. He was widely respected, and was presented with an estate worth 10,000 piastres by the Government of Corrientes. His intention of revisiting Paris was frustrated by his death at Santa Anna in 1858. (See Humboldt's *Travels*.)

BONSTETTEN, Charles Victor de, was born at Bern in 1745, of a noble and ancient family. He received the elements of his education in his native town, and at fourteen was sent to Yverdun, and soon after to Geneva. There he imbibed many revolutionary doctrines both in religion and politics, which ill fitted him for a career as a Bernese senator of the traditional type; and his father, alarmed at the tone of his son's letters, peremptorily ordered him to return home—a command which the young man, albeit he would acknowledge no authority but reason, was obliged to obey. The change, however, was worse than useless; for the dulness of Bern so preyed upon his mind that he made an attempt on his life, which was frustrated by the somewhat curious accident of a ray of the moon attracting his attention when about to discharge the pistol. His father seeing his condition, sent him to Leyden to finish his studies; but as the climate of the place disagreed with him, he was allowed to exchange it for England, which he reached in 1769. The facility with which he gathered friends around him, which distinguished him, perhaps, as much as anything else, made his stay in England not the least happy period of his life. He went home by way of Paris, where he was introduced to much of the best literary society in France, but on his return

he found that the mournful duty awaited him of nursing his father in his last illness. Immediately after his father's death he again left home, and spent a considerable time in Italy, travelling as far south as Naples. Time and experience had done much to alter the character of Bonstetten since the days of his wild theorizings at Geneva. No longer a Republican, but still a Liberal, he was daily recognizing with greater clearness that the watchwords of revolution meant anything but law and order. On returning to Bern he became a member of the avoyer's council, and soon after was appointed magistrate at Gessenay. Thence he was removed in 1787 to Nyon in the Pays de Vaud, a place attractive to him from its proximity to the intellectual life and society of Geneva and Lausanne, but in other respects unsuitable; for the Pays de Vaud, as well from its nearness to France and to Geneva, as from the weight of the Bernese yoke, was nearly ripe for revolt, and Bonstetten was, as a magistrate, trusted neither by his revolutionary friends and former allies, nor by his fellow-rulers in the government of Bern. He firmly declared that he should stand by his order, a declaration that was not without good effects; but in 1792, when Geneva was threatened by the army of the Convention, he took certain steps to avert the danger, which, as he had not received a military training, were not very judicious. This increased the suspicion which the Bernese Government felt towards him; and, in consequence, he was permitted to exchange his office for one on the Ticino, where he remained until 1797, when political troubles and the French armies compelled him to leave his native country. At the solicitation of Madame Brün he at first repaired to Copenhagen, but he finally determined to settle at Geneva, which proved to be his home for the rest of his life. There, as of old, he enjoyed the society of many distinguished persons; but if this last half of his life is the most brilliant, it is also the least eventful. He died in February 1832.

As a writer Bonstetten cannot be said to occupy a very high place. His works, indeed, show a great power of observation, and an extensive insight into human character; but as a psychologist he is deficient in method, exactness, and depth; and his style, like his thought, wants point and clearness. In psychology he occupies an eclectic position, and urges the necessity of making use of internal observation in the study of mind. It is, however, in his social character, as a conversationalist, and as the friend, often the intimate companion, of many of the leaders of thought and action during his long life, that Bonstetten will be best remembered. The following are the titles of his chief works:—*Recherches sur la nature et les lois de l'imagination*, 1807; *Etudes d'homme, ou Recherches sur les facultés de sentir et de penser*, 1821; *Sur l'éducation nationale*, 1802; *Pensées sur divers objets de bien public*, 1815; *L'Homme du Midi et l'Homme du Nord*, 1814.

BONVICINO, Alessandro. See Moretto.

BOOK, the common name for any literary production of bulk, now applied particularly to a printed composition forming a volume. The name is also used for the literary divisions of a work.

Wachter, with some other writers, derives the word from the same root as the German *biegen*, to bend, as the Latin *volumen* comes from *volvere*. But the more common etymology makes the tree the parent of the book, and refers the origin of the latter (Angl. Sax., *boc;* Germ., *Buch;* Dutch, *boek*) to writing on the bark of the beech tree (Angl. Sax., *boc;* Germ., *Buche;* Icel., *beyke;* Dutch, *beuke*), or perhaps on beach boards. Analogy supports this derivation. The *byblos* of the Greeks—whence their name for a book—refers to the Egyptian papyrus itself, and the Latin *liber* to the pellicle which enclosed its stalk. The *codex* of the Romans meant at first the trunk of a tree; and the *leaves* of a book indicate a similar origin.

The earliest writings were purely monumental, and accordingly those materials were chosen which were supposed to last the longest. The same idea of perpetuity which in architecture found its most striking exposition in the pyramids was repeated, in the case of literary records, in the two columns mentioned by Josephus, the one of stone and the other of brick, on which the children of Seth wrote their inventions and astronomical discoveries; in the pillars in Crete on which, according to Porphyry, the ceremonies of the Corybantes were inscribed; in the leaden tablets containing the works of Hesiod, deposited in the temple of the Muses, in Bœotia; in the ten commandments on stone delivered to Moses; and in the laws of Solon, inscribed on planks of wood. The notion of a literary production surviving the destruction of the materials on which it was first written—the "monumentum ære perennius" of Horace's ambition—was unknown before the discovery of substances for systematic transcription.

Tablets (*tabulæ*) of ivory or metal were in common use Tablets. among the Greeks and Romans. When made of wood—sometimes of citron, but usually of beech or fir—their inner sides were coated with wax, on which the letters were traced with a pointed pen or stiletto (*stylus*), one end of which was used for erasure. It was with his *stylus* that Cæsar stabbed Casca in the arm when attacked by his murderers. Two such tablets, joined together, were called *diptycha*,[1] the earliest specimens of bookbinding. They were fastened together at the back by wires, which acted as hinges; the pages were called *ceræ*, from their waxen coating, and a raised margin was left round each to prevent obliteration by friction. Wax tablets of this kind continued in partial use in Europe during the Middle Ages; the oldest extant specimen, now in the museum at Florence, belongs to the year 1301. The leaves of the palm tree were afterwards used in their stead, as also the inner bark of the lime, the ash, the maple, and the elm. But the earliest, though long obsolete, flexible material of importance was Papyrus. made from the concentric coats which wrapped the stalk of the Egyptian *papyrus*, from which is derived our word *paper*. The time of its introduction has been much disputed; but it was certainly known long before Herodotus. The length of the Greek papyri is said to vary from eight to twelve inches; the Latin often reach sixteen. Some rolls, however, have been found as long as thirty feet. They were written on with reeds dipped in gum-water coloured with charcoal or soot of resin, the writing being readily obliterated with a sponge; and it is conjectured that the surface was sometimes prepared for that purpose with a wash or varnish. Pliny mentions also the ink of the cuttle fish as having been used for writing, as well as a decoction of the lees of wine.[2] Red ink consisted of a preparation from cinnabar. The next material commonly employed after papyrus was parchment, made from the skins of animals, usually of Parchm sheep or lambs. Vellum is a finer substance, consisting of prepared calf-skin. Parchment is commonly ascribed to Eumenes, king of Pergamus, in Asia Minor; but he was, in all probability, not the inventor but the improver. Writing on skins is mentioned by Herodotus as common in his day; and Diodorus and Ctesias speak of ancient Persian records on leather. The word itself (*pergamena*) first occurs, according to Mabillon, in the writings of Tatto, a monk of the 4th century. It appears to have superseded papyrus about the 7th century; but its quality afterwards

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[1] See Montfaucon, *Pal. Græc.* p. 34. There are several specimens in the British Museum.

[2] For more on this subject see Caneparius, *De Atramentis cujuscunque generis*, London, 1660; Beckmann's *History of Inventions*; and Becker's *Charicles* and *Gallus*.

deteriorated. At first only one side was written on, the back being frequently stained. Parchments written on both sides are called by Pliny *opisthographi*. The term *boc-fell* is found, in early English, to designate this material. Its dearness in classical times led to the practice of erasing the original writing for the purpose of substituting new. Parchments so obliterated are known as *palimpsests*, from a Greek word signifying twice rubbed, or prepared for writing; and they are alluded to under that name by Cicero (*ad Div.* vii. 18). Paper. Paper made from cotton (*charta bombycina*) came into use, according to Montfaucon, towards the end of the 9th or the beginning of the 10th century; and the invention was opportune, as it checked the further use of palimpsests, which, from the scarcity of parchment and the demand for books of devotion, had imperilled the preservation of much classical literature. Cicero's *De Republica* was discovered by Angelo Mai in the Vatican library written under a commentary of St Augustine on the Psalms; and the Institutions of Gaius, in the library of the chapter at Verona, were deciphered in like manner under the works of St Jerome. But the invention of linen paper gave the first real impulse to book production. The precise date of this invention is disputed; Mabillon refers it to the 12th century. Montfaucon, however, found no specimens earlier than 1270, and Maffei none before 1300; the most numerous of them belong to the 14th century. Scaliger ascribes the invention to the Germans, Maffei to the Italians, and others to certain Greek refugees at Basel; while Duhalde refers it to the Chinese, and Prideaux to the Saracens in Spain. For further particulars respecting the various substances of early books, the reader may consult the first volume of the *Nouveau traité de diplomatique*, by the Benedictines of St Maur, and the *Essai sur l'histoire du Parchemin et du Vélin*, by Peignot, who has given a list of authorities on this subject.

Rolls. The form of ancient books differed with the materials of which they were composed. When flexible matter came into use, it was found convenient to make books in the form of rolls, and the two names are synonymous in legal phraseology to this day. The papyrus, and afterwards the parchment, was joined together to form one sheet, and then rolled upon a staff into a volume (*volumen*). When an author divided his work into portions or "books," in the literary sense of the word, each division was usually a *volumen* by itself,—thus Ovid speaks of his fifteen books of the *Metamorphoses* as so many *volumina*; and the same was done when an entire work was too bulky to be rolled on one stick. The staff in the Herculaneum rolls is concealed by the papyrus, but it usually projected, the ends being ornamented with bosses (*umbilici*) of wood and ivory. The title (*titulus index*) was either suspended like a ticket to the roll, or pasted on the outside. These rolls were frequently protected by a parchment cover; they were deposited in a cylindrical box (*capsa* or *scrinium*), or were arranged horizontally in cases round the walls of a library, as at Herculaneum. Many books could probably be stowed away in small compass by this means; and the smallness of the rooms devoted in ancient times to such collections is readily explained in this manner. The *volumen*, however, in most cases, was far from containing as much as our ordinary books, even in an octavo form. The square form, originally applied to the *codices* or wax tablets joined together in the way described above, was resorted to afterwards for separate leaves, the same name being retained with altered materials. Martial speaks of this later kind of *codex* as a novelty in his day. It was common, however, in Greek MSS., among the earliest of which Montfaucon discovered few specimens of rolls. The term *liber* in the 4th century is found applied to both rolls and squared leaves, but the former were discontinued in the Middle Ages, and covers of boards were gradually introduced, the leaves being stitched together as well as folded.

The internal arrangement of books has undergone many modifications, which belong, however, chiefly to the subject of early writing. At first the letters were divided only into lines, then into separate words, and these by degrees were noted with accents, and distributed by points and stops into periods, paragraphs, chapters, and other divisions. In some countries, as among the Orientals, the direction of the characters was from right to left, in others, as among the Northern and Western nations, from left to right. The early Greeks followed the two directions alternately,—a method which was called *boustrophedon*, from its analogy to the path of oxen when ploughing. In most countries the lines run from side to side, but in some, particularly among the Chinese, their direction is vertical. Internal arrangements.

The diffusion of early books concerns especially the literary historian. Their scarcity before printing is illustrated by the conditions attached to purchase or loan; but it must be remembered that a particular book might easily bear a monopoly price, and that this is no test of the cost of those which might be multiplied by transcription. When, however, the small number of copyists in the Dark Ages and even later is considered, the high prices recorded in many instances do not appear surprising. A curious collection of scattered notices of this kind is given in the first volume of Warton's *History of English Poetry*. A catalogue of the books in the Sorbonne in 1292, consisting of upwards of 1000 volumes, is mentioned by Chevillier[1] as having been valued at 3812 livres, equivalent, according to an English writer, to as many pounds sterling of the present day. In 1425, when the English became masters of Paris, the duke of Bedford, regent of France, sent the whole of the royal library into England; and the collection, which amounted to only 853 volumes, was valued at 2223 livres.

The characteristics of early printed books are noticed under the head of BIBLIOGRAPHY (*q. v.*) The folio and quarto sizes, originally adopted from the largeness of the types in the infancy of printing, are now generally restricted to works of bulk, as dictionaries and other books of reference. The size of a printed book is named from the dimensions of the paper and the number of leaves into which it is folded. The ordinary sizes for a long time were royal, demy, and crown; and the demy 8vo is now the commonest size in use. Post and foolscap are frequently but inaccurately described in catalogues as duodecimo. "Paper-moulds," says Mr W. Blades,[2] a competent authority on this subject, "have fixed conventional sizes; but since the introduction of machines for making paper, and the consequent disuse of moulds, makers work more by a given number of inches than by names of sizes. Consequently, the correct description of book sizes has become impossible, and the trade describe the new by the names of the old size they most resemble. To determine the real size of a bound book," he adds, "find the signature (a letter or figure at the bottom of the page), and count the *leaves* (not pages) to the next. A further test is the binder's thread in the middle of the sheet; the number of leaves from each thread to the next will give the same result. But these rules do not apply to old black-letter books and those of the 15th and 16th centuries, in which the most satisfactory test is the water-mark. The rule is:—a folio volume will have all the water-marks in the middle of the page; a quarto has the water-mark folded in half in the back of the book, still midway between the top and bottom; in an octavo it is at the back, but at the top, and often Printed books.

[1] *Origines de l'imprimerie de Paris*, p. 370.
[2] *Notes and Queries*, 3d series, ix. 83.

considerably cropped by the binder's plough; and a 12mo and 16mo have the water-mark on the fore-edge." For further information regarding MS. books see PALÆOGRAPHY, and for printed books BIBLIOGRAPHY. (E. F. T.)

Bookselling.

The trade in books is of a very ancient date. The early poets and orators recited their effusions in public to induce their hearers to possess written copies of their poems or orations. Frequently they were taken down *viva voce*, and transcripts sold to such as were wealthy enough to purchase. In the book of Jeremiah the prophet is represented as dictating to Baruch the scribe, who, when questioned, described the mode in which his book was written. These scribes were, in fact, the earliest booksellers, and supplied copies as they were demanded. Aristotle, we are told, possessed a somewhat extensive library; and Plato is recorded to have paid the large sum of one hundred minæ for three small treatises of Philolaus the Pythagorean. When the Alexandrian library was founded about 300 B.C., various expedients were resorted to for the purpose of procuring books, and this appears to have stimulated the energies of the Athenian booksellers, who were termed βιβλίων κάπηλοι. In Rome, towards the end of the Republic, it became the fashion to have a library as part of the household furniture; and the booksellers, *librarii* (Cic., *De Leg.*, iii. 20) or *bibliopolæ* (Martial, iv. 71, xiii. 3), carried on a flourishing trade. Their shops (*taberna librarii*, Cicero, *Phil.*, ii. 9) were chiefly in the Argiletum, and in the Vicus Sandalarius. On the door, or on the side posts, was a list of the books on sale; and Martial (i. 118), who mentions this also, says that a copy of his First Book of Epigrams might be purchased for five denarii. In the time of Augustus the great booksellers were the Sosii. According to Justinian (ii. 1, 33), a law was passed securing to the scribes the property in the materials used; and in this may, perhaps, be traced the first germ of the modern law of copyright.

The spread of Christianity naturally created a great demand for copies of the Gospels and other sacred books, and later on for Missals and other devotional volumes for church and private use. Benedict Biscop, the founder of the abbey at Wearmouth in England, brought home with him from France (671) a whole cargo of books, part of which he had "bought," but from whom is not mentioned. Passing by the intermediate ages we find that, previous to the Reformation, the text writers or stationers (*stacyoneres*), who sold copies of the books then in use,—the A B C, the Paternoster, Creed, Ave Maria, and other MS. copies of prayers, in the neighbourhood of St Paul's, London,—were, in 1403, formed into a guild. Some of these "stacyoneres" had stalls or stations built against the very walls of the cathedral itself, in the same manner as they are still to be found in some of the older Continental cities. In Mr Anstey's *Munimenta Academica*, published under the direction of the Master of the Rolls, we catch a glimpse of the "sworn" university bookseller or stationer, John More of Oxford, who apparently first supplied pupils with their books, and then acted the part of a pawnbroker. Mr Anstey says (p. 77), "The fact is that they (the students) mostly could not afford to buy books, and had they been able, would not have found the advantage so considerable as might be supposed, the instruction given being almost wholly oral. The chief source of supplying books was by purchase from the university sworn stationers, who had to a great extent a monopoly Of such books there were plainly very large numbers constantly changing hands." Besides the sworn stationers there were many booksellers in Oxford who were not sworn; for one of the statutes, passed in the year 1373, expressly recites that, in consequence of their presence, "books of great value are sold and carried away from Oxford, the owners of them are cheated, and the sworn stationers are deprived of their lawful business." It was therefore enacted that no bookseller except two sworn stationers, or their deputies, should sell any book being either his own property or that of another, exceeding half a mark in value, under pain of imprisonment, or, if the offence was repeated, of abjuring his trade within the university.

"The trade in bookselling seems," says Hallam, "to have been established at Paris and Bologna in the 12th century; the lawyers and universities called it into life. It is very improbable that it existed in what we properly call the Dark Ages. Peter of Blois mentions a book which he had bought of a public dealer (*a quodam publico mangone librorum*); but we do not find many distinct accounts of them till the next age. These dealers were denominated *stationarii*, perhaps from the open stalls at which they carried on their business, though *statio* is a general word for a shop in low Latin. They appear, by the old statutes of the University of Paris, and by those of Bologna, to have sold books upon commission, and are sometimes, though not uniformly, distinguished from the *librarii*, a word which, having originally been confined to the copyists of books, was afterwards applied to those who traded in them. They sold parchment and other materials of writing, which have retained the name of stationery, and they naturally exercised the kindred occupations of binding and decorating. They probably employed transcribers; we find at least that there was a profession of copyists in the universities and in large cities."

The modern system of bookselling dates from soon after the introduction of printing. The earliest printers were also editors and booksellers; but being unable to sell every copy of the works they printed, they had agents at most of the seats of learning. Antony Koburger, who introduced the art of printing into Nuremberg in 1470, although a printer, was more of a bookseller; for, besides his own sixteen shops, we are informed by his biographers that he had agents for the sale of his books in every city of Christendom. Wynkin de Worde, who succeeded to Caxton's press in Westminster, had a shop in Fleet Street.

The religious dissensions of the Continent, and the Reformation in England under Henry VIII. and Edward VI., created a great demand for books; but in England neither Tudor nor Stuart could tolerate a free press, and various efforts were made to curb it. The first patent for the office of king's printer was granted to Thomas Berthelet by Henry VIII. in 1529, but only such books as were first licensed were to be printed. At that time even the purchase or possession of an unlicensed book was a punishable offence. In 1556 (3 and 4 Philip and Mary) the London Company of Stationers was incorporated, and very extensive powers were granted in order that obnoxious books might be repressed. In the following reigns the Star Chamber exercised a pretty effectual censorship; but in spite of all precaution, such was the demand for books of a polemical nature, that many were printed abroad and surreptitiously introduced into England. Queen Elizabeth interfered but little with books except when they emanated from Roman Catholics, or touched upon her royal prerogatives; and towards the end of her reign, and during that of her pedantic successor, James, bookselling flourished. Archbishop Laud, who was no friend to booksellers, introduced many arbitrary restrictions; but they were all, or nearly all, removed during the time of the Commonwealth. So much had bookselling increased during the Protectorate that, in 1658, was published *A Catalogue of the most Vendible Books in England, digested under the heads of Divinity, History, Physic, &c., with School Books, Hebrew, Greek, and Latin, and an Introduction, for the use of*

Schools, by W. London. A bad time immediately followed. The Restoration also restored the office of Licenser of the Press, which continued till 1694.

In the first Copyright Act (8 Anne, c. 19), which specially relates to booksellers, it is enacted that, if any person shall think the published price of a book unreasonably high, he may thereupon make complaint to the archbishop of Canterbury, and to certain other persons named, who shall thereupon examine into his complaint, and if well founded reduce the price; and any bookseller charging more than the price so fixed shall be fined £5 for every copy sold. Apparently this enactment remained a dead letter.

The modern bookselling trade divides itself into the several branches of publishing and *wholesale bookselling*, and *the retail*, *the old or second-hand*, and the periodical trades. Publishing is confined to a few of the larger cities, London naturally taking the lead, followed by Edinburgh, Glasgow, Oxford, Manchester, Liverpool, Cambridge, Dublin, and a few other places; while purely wholesale dealers are to be found in the large towns only. In Great Britain, and especially in Scotland, booksellers are located in every small town; but in Ireland there are very few, except in the chief cities. Formerly the retail booksellers were expected to demand the full retail price of a book, and make no greater reduction than discount for ready money; but this restriction has been discontinued as contrary to the spirit of free trade. The trade in old or (they are sometimes called) second-hand books is in a sense a higher class of business, requiring a knowledge of bibliography, while the transactions are with individual books rather than with numbers of copies. Occasionally dealers in this class of books replenish their stocks by purchasing remainders of books, which, having ceased from one cause or another to sell with the publisher, they offer to the public as bargains. The periodical trade is entirely the growth of the present century, and was in its infancy when the *Penny Magazine*, *Chambers's Journal*, and similar publications first appeared. The growth of this important part of the business has been greatly promoted by the abolition of the newspaper stamp and of the duty upon paper, the introduction of attractive illustrations, and the facilities offered for purchasing books by instalments.

The history of bookselling in the New World has yet to be written. The Spanish settlements in America drew away from the old country much of its enterprise and best talent, and the presses of Mexico and other cities teemed with publications mostly of a religious character, but many others, especially linguistic and historical, were also published. Bookselling in the United States was of a somewhat later growth, although printing was introduced into New York as early as 1673, Boston in 1674, and Philadelphia in 1683. Franklin had served to make the trade illustrious, yet few persons were engaged in it at the commencement of the present century. Books chiefly for scholars and libraries were imported from Europe; but after the second war printing-presses multiplied rapidly, and with the spread of newspapers and education there also arose a demand for books, and publishers set to work to secure the advantages offered by the wide field of English literature, the whole of which they had the liberty of reaping free of all cost beyond that of production. The works of Scott, Byron, Moore, Southey, Wordsworth, and indeed of every author of note, were reprinted without the smallest payment to author or proprietor. Half the names of the authors in the so called "American" catalogue of books printed between 1820 and 1852 are British. By this means the works of the best authors have been brought to the doors of all classes in the cheapest variety of forms. In consequence of the war with the Southern States, the high price of labour, and the restrictive duties laid on in order to protect native industry, coupled with the frequent intercourse between the two countries, a great change has taken place during the last few years. Books printed and bound in Britain are greatly appreciated, and American publishers, in the absence of an international copyright, make liberal offers for early sheets of new publications. Boston, New York, and Philadelphia still retain their old supremacy as bookselling centres.

In Australia the sale of books is not large at present; there are, however, indications of a great increase. The booksellers there as in Canada, although supposed to be bound by the copyright law restricting the sale of any but genuine editions, avail themselves of American and other reprints, in which the authors have little or no interest.

In the course of the 16th and 17th centuries the Low Countries for a time became the chief centre of the bookselling world, and many of the finest folios and quartos in our libraries bear the names of Jansen, Blauw, or Plantin, with the imprint of Amsterdam, Utrecht, Leyden, or Antwerp, while the Elzevirs besides other works produced their charming little pocket classics. The southern towns of Douai and St Omer at the same time furnished polemical works in English.

Germany, the birthplace of the art of printing, is still the first bookselling country in the world. There, distributed over 786 towns, are 3473 publishers and booksellers, Leipsic being the centre to which they all look, all of any consequence having an agency there, where their books are collected, and their own publications distributed. In Leipsic there are 105 commission-agents for 4202 booksellers, of whom 1143 carry on business in Austria, France, Russia, Holland, America, and England. The book exchange has 115 members who transact business there. The other centres of the German book trade are Stuttgart, with 16 agents for 542 booksellers; Vienna, with 31 agents for 475; Berlin, with 29 agents for 305; and Prague, with 18 agents for 98. The great book fair at Leipsic is held every year immediately after Easter, and is attended by booksellers from every part of the world.

In France the press is still shackled, and every book and pamphlet must be registered before publication; but notwithstanding this booksellers flourish, especially in all the large towns, and some of the finest illustrated works of the day are issued from the French press. In Italy booksellers are few, and in Spain they can hardly be said to have any existence at all.

From the *English Catalogue of Books for* 1874 it appears that there were about 4500 books published in Great Britain and Ireland during that year. This number includes new editions of works previously issued, as well as the principal books published in the United States.

The values of books exported and imported during 1874 are given in the official returns as follows:—

Exports.

To United States	£274,373
„ Australia	267,658
„ British India and Ceylon	83,259
„ British N. America	69,127
„ France	41,622
„ South Africa	35,986
„ Holland	21,912
„ Germany	19,894
„ Belgium	16,953
„ British West Indies and Guiana	14,469
„ Other countries	59,539
Total	£904,792

Imports.

From France	£57,680
„ Germany	36,494
„ Holland	31,837
„ United States	17,807
„ Belgium	16,254
„ Spain	4,177
„ Italy	1,328
„ Other countries	13,359
Total	£178,956

Much interesting information on the book trade will be found in Charles Knight's *Biography of William Caxton*,

and in the same author's *Shadows of the Old Booksellers*, 1865. See also *History of Booksellers*, by Henry Curwen, 1873, and *Bilder-Hefte zur Geschichte des Bücherhandels*, by Heinrich Lempertz, Cologne, 1854.

BOOKBINDING is the art of fastening together the sheets of paper composing a book, and enclosing them in cases of pasteboard covered with leather, cloth, or other materials,—the object being the preservation of the book, and its protection from injury while in use.

At the time when books were rarities, being either manuscripts produced by patient secluded labour or the productions of the printing-press during the infancy of typography, they were naturally very highly prized; and as much labour and expense were bestowed upon the protection and embellishment of a cherished folio as would suffice at the present day for the building of a house. The wooden cover of a book, with its metal hinges, bosses, guards, and clasps, seems, in all but dimensions, fit for a church door; but the great improvement in all the mechanical arts, together with the extension of education to all classes, and the consequent diffusion of knowledge, has led to the multiplication of books, and the gradual but radical changes witnessed during the present century in the art of bookbinding.

For a period of one thousand years—from the end of the 5th to the 15th century—books were excessively rare and costly, and comparatively few bindings illustrative of the art during the Dark Ages have been preserved to the present day. From being the task of slaves during the Roman empire, the transcribing of books came to be the duty of monks, who copied and bound the works which were among the chief treasures of religious establishments. Numerous documents exist indicating the attention which was given by all grades of the priestly order to the binding and preservation of their literary treasures. The general aspect of monastic bindings was thick, heavy, and solid, and according to modern ideas somewhat clumsy. Books for common use were enclosed in boards of hard wood covered with leather, with the binding protected by metallic bosses, corner plates, and clasps. The literary treasures, on the other hand, of kings and ecclesiastical dignitaries, and the sacred volumes of churches and monasteries, were encased in ivory sides, with appropriate subjects artistically carved on them, in silver and sometimes even gold *plaques*, or in the enamels of Limoges, &c.; and these bindings were frequently enriched besides with gems and jewels. Often these precious volumes were, in keeping with ancient customs, further preserved in boxes or cases no less rich and costly than the bindings they were meant to preserve. As the period of the Renaissance approached, silk and velvet came into use for ornamental bindings.

The most ancient binding in the British Museum is the St Cuthbert gospels and manuscript, written about the beginning of the 8th century, bound in velvet intermixed with silver, with a broad silver border, enriched with inlaid gems. One of the most ancient and remarkable of bindings, a *Lectionarium*, which was formerly in the collection of M. Libri, that eminent bibliophile thus describes in his *Monuments inédits*: "Manuscript upon vellum of the 11th or 12th century in an ornamented cover (forming a diptych), both sides being gilt and silvered metal, with ivory carvings, figures in *alto rilievo*, and enamels *en taille d'épargne*. The borders contain thirty-two large ivory medallions (sixteen on each side), representing the old prophets and saints, with their symbols, and having inscriptions in ancient uncial letters, the whole surrounded with a foliage of ivory work in the Greek style, and with baguettes carved in compartments. The ivory medallions are very early, probably as old as the 6th century, whilst the enamels and metal ornamentation are specimens of the handiwork of a rather later period. . . . This *Lectionarium* has evidently been inserted in the present cover at a later period, the original one having most probably been damaged or destroyed by use." Referring to this work, M. Libri, in the introduction to the volume above quoted, says: "Whether the enamels contained in this binding are Byzantine and contemporary with the ivory sculptures, or were introduced later (as we have shown was frequently the case) into an older covering, the medallions and other workmanship in ivory, adorning the sides of this coating, appear, from the character of the heads, from the inscriptions, and from the workmanship itself, to date back to the earliest period of the Byzantine school."

With the invention of printing, and the consequent multiplication of books in a portable shape, came the modern style of bookbinding. The old massive boards, with their bosses, corner plates, and heavy clasps disappeared, and thin sides covered with leather, parchment, and vellum came into use. Bindings in which enamels, precious metals, or gems were employed almost entirely disappeared, and were followed by bindings in richly-coloured leather or vellum, with elaborate designs, blind-tooled or worked in gold and colour, and gilt gauffré edges. By the wealthy and powerful families of Italy this style of binding and ornamentation was first encouraged towards the end of the 15th century, and skilful artists were employed to design appropriate decorations to be worked out by the bookbinders. Among the most famous early patrons of the bibliopegic art in Italy were Michael and Thomas Maioli, the books of the latter being the models on which were fashioned the bindings of later collectors and of other countries. More rare and artistically valuable still are the works of another Italian collector of the 16th century, Demetrio Canevari, commonly called Mecenate, physician to Pope Urban. They are distinguished by a medallion executed in gold, silver, and colour, with the device of a charioteer driving towards Pegasus on an elevation, and the motto, ΟΡΘΩΣ. ΚΑΙ. ΜΗ. ΛΟΞΙΩΣ. These elegantly gilt bindings have, in the opinion of M. Libri, never been surpassed.

Artistic bindings of Italy and Italian binders were brought to France by Charles VIII. and Louis XII.; but it was not till the time of Francis I.—himself a lover of books and bindings—that Grolier, his military treasurer and the governor of Milan, brought the French school of binding suddenly to the front, and placed it, where it long remained, at the head of the art in Europe. The bindings executed for Grolier usually contain on their obverse the inscription, IO. GROLIERII ET AMICORUM, and on the reverse his usual motto was PORTIO MEA DOMINE SIT IN TERRA VIVENTIUM. Of Grolier's bindings the learned De Thou, a later and little less famous French bibliophile, remarked "that his books partook of the elegance and polish of their owner." The Grolier style is yet recognized as the most chaste, elegant, and appropriate method of book ornamentation, and it immediately attained an enormous reputation in France. "The very tools used by his binders," remarks M. Libri, "were employed for contemporary collectors, and his admirable patterns have been imitated and copied by other French bibliophiles. The gradual change in those patterns is very perceptible. At first they were formed by a simple and chaste combination of various links only; but afterwards Grolier successively introduced into the designs more rich ornaments, such as small flowers, wreaths, &c." Some of his later covers were resplendent with gold and coloured ornament, most elaborately tooled.

After the period of Grolier the taste for magnificent bindings in France grew into a passion, and the sumptuous bindings in which the famous Diana of Poitiers indulged

are almost without parallel. The designs for many of her bindings are said to have been prepared by order of her royal lover Henry II., under the superintendence of the celebrated artist Le Petit Bernard. Her books are marked with her favourite symbols, the lunar crescent and the bow, and the monogram D ɑ, sometimes (probably in the case of love-gifts) with the H of Henry interlaced, and surmounted by the crown. It would be a useless and almost endless task to name the patrons of artistic bindings up to near the period of the revolutionary outbreak, during which long time French binders stood at the head of their craft. Such outstanding names among many bibliophiles as those of the historian De Thou (Jacobus Augustus Thuanus) and Colbert, the minister of Louis XIV., cannot be passed over. Such was Colbert's care for artistic bookbinding that, in a treaty with Marocco, he inserted a stipulation for a certain number of skins annually to be used for bindings in the *Bibliothèque Royale*. Much less is known concerning the bookbinders themselves than of their patrons and the works they executed; but prominent among the bibliopegic artists of all times stand the chief French *relieurs* of the 17th and 18th centuries—Le Gascon, Abbé Dusseuil, Padeloup, and Derome. Bindings by these artists are among the esteemed prizes of modern collectors.

Although during the 16th and 17th centuries bindings were produced in England which suffer no disgrace by comparison with contemporary masterpieces of French, Italian, and German bibliopegy, it was not till well into the 18th century that England took the leading place in the workmanlike forwarding and artistic finishing of books. Silk and velvet long remained the favourite coverings for the more costly bound books in the royal library, and down to the time of James I. we find very elaborately worked bindings in these substances. But, at the same time, there are not wanting magnificent examples of work in calf, morocco, and vellum, with blind and gold toolings, and gilt gauffré edges. The bindings of John Reynes, bookbinder to Henry VIII., had embossed on them the curious heraldic conceit of a shield, supported by a pair of unicorns, charged with the emblems of the passion, and along with his monogram the inscription *Redemptoris mundi arma*. Before James VI. of Scotland came as James I to the English throne, he was, as became his literary character, a collector of books and a lover of bindings. John Gibson of Edinburgh held, under James, the office of royal binder, with an annual salary of £20 Scots. A detailed list of bindings, with the prices charged by Gibson, is printed by the Bannatyne Club in *The Library of Mary Queen of Scots and James VI.* Mr J. T. Gibson-Craig of Edinburgh has in his excellent collection an original Scotch binding from the library of Queen Mary, the *Cronique de Savoye*, a small folio in brown calf, richly tooled in silver, with the Scottish arms, and the initial M. The same collector also possesses a Scotch binding in brown calf, with blind and gold panelling, gilt and gauffré edges, with the name and arms of the Earl of Bothwell, the third husband of Queen Mary. De Quincey, in a paper on "Secret Societies," ranks a Bible bound by Mr Farrer in 1635 above the *chefs d'œuvre* of British and Continental artists.

The acknowledged supremacy attained by English bookbinding in the latter half of last century is due in large measure to the work of Roger Payne, a man gifted with extraordinary skill, dexterity, and taste, but unfortunately also of the most erratic and dissolute habits. Payne's work was, as he himself expressed it, "very carefully and honestly done;" his tooling especially was very beautiful, and his ornaments, many of which he fashioned with his own hands, were at once highly appropriate and artistic. In his bills he was in the habit of taking his patrons into his confidence in an unusual manner, and one of these may be worth copying.

"*Aeschylus Glasguæ MDCCXCV Flaxman illustravit.* Bound in the very best manner, sew'd with strong Silk, every Sheet round every Band, not false bands: the Back lined with Russia Leather, Cut Exceeding large; Finished in the most magnificent manner. Embordered with ERMINE expressive of The High Rank of the Noble Patroness of The Designs, The other Parts Finished in the most Elegant Taste with small Tool Gold Borders Studded with Gold; and small Tool Panes of the most exact Work. Measured with the Compasses. It takes a great deal of Time making out the different measurements, preparing the Tools, and making out new Patterns. The Back Finished in Compartments with parts of Gold studded work and open Work to relieve the Rich close studded work. All the Tools except studded points are obliged to be worked off plain first, and afterwards the Gold laid on and Worked off again. And this Gold Work requires double Gold being on Rough Grained Morocco. The impressions of the Tools must be fitted and cover'd at the bottom with Gold to prevent flaws and cracks."

Payne, in poverty and distress, came prematurely to a drunkard's grave in 1797. His style of binding has still many admirers, and the Roger Payne style is one of the established methods of finishing in bookbinders' establishments at the present day. After Payne, Charles Lewis was the next famous English binder flourishing in London in the early part of the present century, and his bindings come down to and connect with the work of bibliopegistic artists who still exercise their calling.

The operations of bookbinding are now carried on upon a scale which could not have been dreamt of even at the beginning of the present century, and the millions of volumes which annually issue from the press could not possibly be put into the hands of the reading public in the form and at the price at which they are sold without the aid of machinery. In Great Britain nearly all books are first issued in cloth cases, and while the greatest variety of grain and colouring has been reached in the preparation of the cloth for such cases, their gilding, embossing, and lettering, all accomplished by machinery, leave almost no improvement to be desired, and the most handsome and fairly durable bindings can thus be supplied at an incredibly small cost. At the same time, it is practicable to prepare, emboss, and gild cheap leather covers by the same processes and machinery adopted for cloth cases, and the bindings of cheap family and pocket Bibles are thus produced. But although the old solid and substantial handiwork of the craft is thus fairly eclipsed, there is still employment—and more employment than ever—for binders in leather, who chiefly rely on manual dexterity for the forwarding of their work, and individual taste and skill for its artistic finishing.

Modern bookbinding thus divides itself into two principal branches—1st, Leather work, and all kinds in which manual labour and skill are chiefly employed; and 2d, Cloth-casing, or such work as is largely executed by the aid of machinery.

It may be convenient first to notice the various operations through which a book passes in ordinary or leather binding. These operations are grouped under two main divisions—"forwarding" and "finishing." Under the first is comprehended everything necessary to the preservation of a book; the second concerns merely the embellishment.

Forwarding.—In the first place, the sheets of a book are *folded* in such a manner that the pages follow each other in consecutive order. In this operation the binder is guided by the "signatures," which indicate the part of a sheet to be superimposed upon another. This labour is performed by women and girls, who acquire incredible dexterity by continued practice. The sheets, after being folded, are loose and bulky. The next operation has for its object the bringing them into a more compact form, which was formerly accomplished by beating them with a broad-faced hammer upon a smooth flat stone. The condensing or compacting is now generally accomplished by passing the sheets between the cylinders of a rolling-machine. A quantity of sheets, called a "section," is gathered and arranged between two pieces of tin plate and passed through

between the powerful cast-iron rollers of the machine. After rolling, the sections composing a volume, supposing it to have been necessary to press it in more than one division, are brought together and carefully collated. The whole of the sheets to compose the volume being found in their proper place and order, they are taken in sections to the standing-press, in which a number of them are piled up between boards. The form of standing-press generally used is what is termed the Atholl or Isle of Man press, on account of the three arms, or rather legs, by which the compound screw of the press is worked.

The volumes are then adjusted and clamped up in the laying or cutting-press for the operation of *sawing the back*. Two or three grooves are, in this operation, sawn straight across the back of the volume, according to the number of bands on which the book is to be sewed. In these grooves the bands are lodged, so that when the sewing of the book is complete, the bands are "flush" with the rest of the back, instead of projecting out as they did in old times. A slight cut is made near each end for holding the "kettle stitch," or stitch by which the sewer fastens her thread each time she passes up and down. The *sewing* is done at an apparatus called the sewing-press or frame, upon which the number of cords to be employed are fastened at proper distances, in accordance with the saw-marks in the back of the volume. The method of sewing varies according as the sewer is working one or two "sheets on;" and the number of bands employed may be from two to six, according to the size of sheet, weight of the book, &c. When taken out of the sewing-frame the fly-leaves are pasted on, and the volume being neatly squared, the back is covered with a coating of thin glue; it is then laid on a board and allowed gradually to dry. When the glue is quite dry the back is *rounded* by beating with a hammer, and subsequently the volume is placed between two feather-edged boards, above which the back slightly projects. These are then placed together in a lying-press, for the *backing* process, that is, the back of the book is well beaten until it projects a little over each side of the bevelled board, so as to form a groove or place for the millboard covers to lie in. The book is now ready for the *boarding*. The boards were formerly, as the name indicates, really of wood, but now of millboard of various thicknesses, according to the size of the book. They are cut a little larger than the book itself, and are attached by the ends of the bands, left for that purpose, being passed through holes in the sides of the boards. The ends of the slips or bands are then frayed out, pasted down, and hammered flat and smooth. The volume is next placed between pressing boards, and put with others into the standing-press, where it is submitted to a powerful pressure for several hours. Thereafter it is again fastened into a lying-press for cutting or *ploughing* the edges with a knife-edged instrument called the plough. The object of the binder in this operation is to make every page of uniform size, presenting a smooth and equal "head," "tail," and "fore-edge." The binder is careful to leave as broad a margin as practicable; but the size of the smallest sheet is the real gauge of the whole book. The head is first cut, next the tail, and before the face is cut it is necessary to have the back flattened by passing "trindles" through between the cords and the boards. After the face has been ploughed the back springs back into its rounded form, and thus the face presents the appearance of having been cut in the round.

The book is now ready to have its edges either *sprinkled*, *coloured*, *marbled*, or *gilt*. *Sprinkling* is accomplished by merely mixing the colour or colours with paste or size, and throwing the mixture from a brush violently on the edges. The uniform *colouring* of the edges is done by screwing the volume up in the lying-press and applying the colour with a sponge. *Marbling* is usually carried on as a separate trade, and requires considerable adroitness. The colours to be used are thrown into a square shallow trough containing prepared gum water, and as they float on the top they are dexterously mixed and combed through each other so as to produce the kind of marble pattern desired. In this the edges to be marbled are dipped, and when they are withdrawn it is found that the marbled colours have adhered to them. In the *gilding* the fore-edge or face is first operated on; and to level it the back must again be flattened, as in ploughing. The book is then firmly fixed in the lying-press, and the edges are scraped and smoothed with a steel scraper. The edges are next coloured, the gold size, consisting of white of egg mixed with water, called glaire, is laid on with a camel's-hair brush, and immediately covered with gold leaf. When dry, it is burnished by rubbing with an agate burnisher, and the head and tail are put through the same processes. Gilt edges in early bound books were usually *gauffré*, *i.e.*, had designs impressed on them; but scarcely any such work is now done.

The head-bands, which are next attached to the back head and tail, are ornamental appendages, which partly conceal the folded-in edges of the leather, and give a finished aspect to the book. They consist of strips of vellum or parchment worked over with coloured silk or cotton, and are partly glued to the backs and partly fastened by threads passing through the kettle stitches. The back is then lined with strong paper glued on it, two or three thicknesses being used according to the weight of the book. Nearly all books are now bound with open or elastic backs, that is, with the leather of the cover not attached to the back of the sheets. The elastic back is composed of a strip of thin cardboard as long as the volume and a little broader than the back, so that it covers the whole back, and is glued in the joint at the edge of the millboards. Across this elastic back false bands are glued to imitate the projections produced by the cords of ancient bindings; and when these are dry, the book is ready for covering.

The materials used for *covering* are very various; but for the greater part of modern books calf-skin dyed of various colours is employed; while kid-skin, and its imitation in sheep-skin or roan, and sheep-skin acknowledged as such, in which school-books and many law-books are bound, are also used in great quantities. The piece of leather, cut to a proper size, is moistened with water, next covered on the inner side with paste or glue, and then applied evenly to the millboard sides. The superfluous edge of the leather, first pared to reduce its thickness, is turned over on the inside, and concealed from view by the end papers attached to the sheets forming the book, which are subsequently pasted down upon the millboards. As a last operation in forwarding, but one now frequently omitted, the book is "corded," that is, firmly tied between two boards until it is dry, so as to insure perfect smoothness in the cover. A book is *half-bound* when only the back and corners are protected with leather, the rest of the boards being covered with prepared paper or cloth.

Finishing.—Finishing processes are so varied and numerous, according to the material under treatment and the effect to be produced, that a lengthy treatise would be required to detail the operations. It will suffice here to notice the operations in finishing an ordinary white-calf binding. The whole of the leather is first washed over with a thin paste of the consistency of cream and allowed to dry. The colouring is then done by brushing over it a solution of "salts of tartar" (tartrate of potash), which produces the brown tint of ordinary bindings. If the sides are to be further ornamented, as, for example, by forming "tree-calf," they are washed over with glaire (white of egg). Each board when dry is separately bent convex, and water is sprinkled on till it runs downwards from the central ridge in a great number of separate branching runlets. As the water is so running, a solution of copperas is sprinkled on and carried along and out by every tricklet, and thus the dark-coloured branched markings are produced. The appearance of "French calf" is produced by dabbing copperas from a sponge on the brown covers. The back is next *pieced for title*, by pasting a piece of coloured morocco into the space between the first and second bands. The points at which lines either blind or in gold are to cross the back are then marked, the whole back is washed with thin paste, and two coatings of glaire are applied to it. When dry the gold leaf is laid on, the lines and ornaments are tooled, and the title lettered with tools and letters which have been heated at a gas stove. The superfluous gold is cleaned off, and after polishing the whole with a hot iron tool the back is finished. The same processes are followed with the sides and the "squares" when any ornamentation is tooled upon them. In the case of finishing of a high class, in morocco, &c., the ornaments are first tooled blind, glaire is pencilled into the lines, and allowed to dry, and gold leaf is then laid on and tooled in. A book is said to be bound *extra* when well forwarded, lined with superior paper, and gilt round the sides and inside the squares.

Casing.—Previous to the year 1825, new books were generally issued in *boards*, that is, in millboards covered with drab paper, upon which the title, printed on a white label, was pasted. Although this was greatly superior to the Continental mode of covering new books with thin paper, something more elegant and durable was needed, and Mr Archibald Leighton of London endeavoured to meet this want by introducing coloured cloth (glazed calico). One of the first books of importance bound in this material was the edition of Lord Byron's works in seventeen volumes. The covering of books in cloth cases can be done profitably only in a factory where there is much division of labour and many labour-saving machines. In cloth binding the preparation and ornamentation of the cases are throughout distinct from the preparation of the sheets, and it is only in the very last stage that the volume and its case are brought together. The first process in the preparation of the cloth cases is cutting the millboard. This is now effected by a rotary cutting-machine or "ripper," an invention introduced from America, whence indeed comes most of the machinery used in this species of binding. The machine consists essentially of a pair of strong spindles placed above each other, on which are mounted circular scissor-edged discs, which cut in pairs like the blades of a pair of scissors. The cutting discs can be arranged on the spindles to cut any desired size of board, and the gauge-frame on the feeding table pushes the pieces of millboard into the machine by a motion communicated by a cam-wheel. Such a machine will cut 50,000 pairs of boards in the working hours of a week. When the boards are to be bevelled this is done in a kind of planing-machine. The cloth for the covers being cut to the required size and covered with glue, a pair of boards are laid on with the help of a brass gauge,

which keeps them parallel, and regulates the width of the space to be left for the back. A strip of paper is pasted into the back, the edges of the cloth are laid in, and the boards are passed between a pair of india-rubber rollers, by the pressure of which any air-spaces between the cloth and the millboards are squeezed out. They are then hung up to dry previous to receiving title and ornamentation. The ornamentation on book cases consists of embossing or blind tooling, black or colour printing, and gilding; and the machines in which the work is done are the same in principle. They are powerful presses, worked either by long lever handles or by power with heavy fly-wheels. Blind patterns, or gilded work and titling, are done at one operation, the dies containing the pattern being heated either with steam or gas. In the case of ornaments to be printed in ink, the pattern is first blocked in the blind with a heated die, and subsequently ink-printed in the same press with the die cold.

The gathering, collating, and stitching of the sheets differ in no way from the same processes already described for leather work. Machinery has been adapted for folding, but, for the working of folding-machines, guide points require to be printed on the sheets, as books must be folded by the type and not by the edge of the sheet. A machine of American origin, besides folding 8vo sheets, will cut, fold, and insert the half sheet of a 12mo. This machine, attended by a single girl, is sufficient to fold from 1200 to 1500 sheets in an hour. The folded sheets are sometimes condensed in another American machine called "The Smasher," which is similar in its action to the embossing press. After stitching, books which are to be cased up with uncut edges have their face and tail cut square by means of a trimming-machine. The principle of this machine consists in a revolving circular knife driven with a treadle or handle; a table (containing the gauge, press bar, and rest), upon which the books are placed, glides across the axis of the knife, and the parts requiring cutting off, coming in contact with the revolving knife, are cut away. When the edges are to be gilt they are cut in some of the numerous forms of guillotine cutting-machines. The commonest form of guillotine is a heavy knife fixed in a strong framework, and having a diagonal motion in its descent by which it cuts with a kind of shearing action. In another machine the knife acts with a punching motion, and cuts the three edges in one descent; and there is in use a most ingenious American machine, with a revolving table, in which each edge of the book is in succession drawn in a slanting direction up against a fixed cutter. The edges are gilt as in ordinary binding, but instead of each volume being operated on singly, a number are placed evenly in a lying press and gilt simultaneously.

After trimming or gilding, as the case may be, the backs are glued up, and when dry they are rounded, generally with the hammer. Several machines have been devised to perform this operation, and one patented in 1865 by Messrs Cope and Bradbrook has come into extensive use. In this machine the book is clamped up between a pair of horizontal cheeks on a table which moves backwards and forwards under a heavy roller adjusted in a frame over the table. The pressure of the roller against the back gives the required "round," which can be varied by raising or lowering the pitch of the roller. From the rounding process the volume goes to the backing-machine, by which the joint or groove along the back in which the boards lie is formed. The backing-machine is worked by the hand, and its action is somewhat similar to that of the rounding-machine. The book is seized between a pair of jaws, which only leave about a quarter of an inch projecting above them. The workman brings down a roller on this projecting part of the volume, and its pressure forces the free portion of end sheets over the sides of the jaws, thus forming the joint to receive the boards. With the backing the part of the work done by machinery ends. The backs are next coated with glue, pieces of calico for pasting down are laid on, and the entire back is covered with paper. When dry, the volume is fitted into its cases and "pasted up," and the operations are finished by piling the cased books in a hydraulic press between boards, so as to leave only the backs projecting.

A kind of binding in which the process of sewing is dispensed with, and the backs coated with a rapidly-drying solution of india-rubber, was patented by Mr William Hancock in 1836, and is still used to some extent. The sheets in this binding must either be cut into single leaves or folded as folios, as they all require to be agglutinated by repeated coatings of the india-rubber solution. The india-rubber backing is convenient for volumes of plates, music books, and any volumes made up of large separate sheets.

Although cloth casing is found sufficient for the greater proportion of the literature which now circulates so extensively, books of reference and works in public libraries require the more secure and workmanlike binding accomplished by hand. At the same time, while ornaments stamped from dies may be very pretty and effective, they have no claim to rank as works of art, and for the collections of bibliophiles the hand-tooling of bibliopegic artists is in as great demand and as handsomely remunerated as was the art of the most accomplished binders of the 16th century. (J. PA.)

BOOK-KEEPING.—The object of book-keeping is to exhibit a distinct and correct state of one's affairs, and to enable companies, firms, and individuals in trade, or otherwise occupied, to ascertain at any time the nature and extent of their business, the amount of their profits or available income, or, as the case may be, the extent of their losses.

To those engaged in trade or commercial pursuits book-keeping is absolutely necessary, as by it all transactions should be regulated, and their results exhibited. The more simple the system the better; but care must be taken that the plan adopted is sufficiently comprehensive and explanatory, to satisfy not only the person keeping the books, but those who may have occasion to refer to them; for, however satisfactory it may be to a trader to follow a system which is intelligible to himself alone, circumstances might arise to render the inspection of others necessary, and from their inability to follow out transactions in the books, suspicions would probably be engendered for which there was no real foundation. Hence the necessity for the adoption of certain recognized and approved systems, which, being plain and easily understood, must prove satisfactory to all concerned.

Book-keeping, when conducted upon sound principles, is invaluable; it not only shows the general result of a commercial career, but admits of analysis, by which the success or failure, the value or utter worthlessness of its component parts, or each particular transaction, can be easily ascertained. In a word, on the one hand it promotes order, regularity, fair dealing, and honourable enterprise; on the other, it defeats dishonesty, and preserves the integrity of man when dealing with his fellows.

It would be difficult, and perhaps of little importance, to trace the origin of book-keeping. It was certainly known to the ancients (see Pliny, lib. ii. cap. 7); and Cicero seems to have had bill transactions between Rome and Athens when he arranged for his son's education without the necessity of having to remit money (see *Epis. ad Att.* xii. 24; xv. 25), which infers some kind of book-keeping. Kelly, however, who wrote on the subject in 1805, asserts, and it is not disputed, that a friar, named Lucas di Borgo, whose work on algebra was the first to appear in print, was the first to write a treatise upon book-keeping, and this was published at Venice in 1495.

This work was followed by many others, possessing considerable merit, but so complex as to make them useless. After a time the mercantile community became alive to the fact that a practical system would be preferable to the theoretical suggestions of writers who were utterly ignorant of commercial matters; and men, more or less connected with trade, began to write on the subject. The incubus of prolixity, however, still clung to them, conciseness of style seeming an impossibility, and the great fundamental principles of the art were so smothered by rules and explanations—the volumes sometimes containing 500 or 600 pages—that the difficulty was how to apply them; hence the need of still greater simplicity and improvement.

In 1796 Mr E. T. Jones of Bristol devised a plan "for keeping books correctly," breaking the ice with a treatise which is still held in very high estimation. After that a great improvement is visible in the writings of authors on this important subject, as in those of Benjamin Booth (1789), Hamilton (1820), Jones (2d treatise, 1821, 3d treatise, 1831), C. Morrison (1823), W. and R. Chambers, Edinburgh,—the most of them, those of Jones excepted, being elementary works, more particularly adapted to schools, and illustrating the principles of the science by the example of one set of books adapted to foreign trade. In F. H. Carter's *Practical Book-keeping, adapted to Commercial and Judicial Accounting* (3d ed. 1875), which gives a great variety of forms and sets of books, the recognized

systems of book-keeping are practically applied, so as to enable any one, without difficulty, to acquire a thorough knowledge of the science.

The questions to which a satisfactory system of book-keeping gives the trader ready and conclusive answers are such as relate—1. To the extent to which his capital and credit will entitle him to transact business; 2. To the assurance he has that all his obligations are honestly fulfilled; 3. To the ascertainment of the success or failure of his commercial dealings, and the position of his affairs from time to time.

There are three recognized systems of book-keeping, namely, by "single entry," "double entry," and the "mixed method."

I. Single Entry.—This system is denoted by its name, transactions being posted singly, or only once, in the ledger. Three books are generally kept—the cash book, day book, and ledger, although the first-named is not essential, the cash entries being passed through the day book. Its only use is to check the balance of cash in hand. In the day book are entered daily all the purchases and sales, whether for cash or credit; and all the credit entries are then transferred to accounts opened in the ledger, that is, all goods sold on credit are charged against the customers, and what are purchased are carried to the credit of parties supplying them. In the same way, when cash is received from a customer for goods sold on credit, it is posted to his account, and the reverse entry is made when a trader pays for the goods he has bought. Thus it will be seen that only personal accounts are entered in the ledger.

To frame a balance sheet, or state of affairs, on this system, the book-keeper brings down the balances due by customers to him, also his stock of goods as valued, and the cash he may have in hand, on the *left-hand side* of the sheet; whilst on the *right-hand side* he enters the balances still due by him for goods supplied, or money lent to him, and the capital, if any, with which he commenced business. The difference between the amounts of the two columns is either profit or loss; if profit, the merchant's capital is increased to that extent, and if loss, then he is so much the poorer.

The following skeleton balance sheet will give a better idea of the working and ultimate results of the system:—

Balance Sheet by Single Entry.

Assets.	£	s.	d.	*Liabilities.*	£	s.	d.
To Sundry Customers for Goods sold, per List......	216	10	0	By sundry Tradesmen for Goods supplied, per List.	184	7	8
,, Goods in Stock, per Inventory and Valuation..	314	9	6	,, Capital put into the Business........................	300	0	0
,, Cash in hand..	3	4	9				
					484	7	8
				,, Profit on Business to date	49	16	7
	534	4	3		534	4	3

It will be observed that as the assets exceed the liabilities (including capital) by £49, 16s. 7d., that sum, being profit, must be added to capital; if, in the next or following years, any loss should emerge, as a matter of course such deficiency must be deducted from the trader's capital. The advantages of single entry are simplicity and easy adaptation to small retail trades, as the ledger contains only outstanding debts due to or by the trader. The disadvantage is in the difficulty of ascertaining the profits or losses on various goods, or on the several departments of a business.

II. Double Entry.—It is now universally admitted that this system is the best adapted for heavy, responsible, or speculative trades, for foreign trade especially, and for extensive mercantile concerns. As its name implies, it so far differs from the system already described, that every transaction must be recorded doubly in the ledger, that is to say, accounts must be opened in that book, to which all entries in the subsidiary books, after being journalized, are twice carried, to the debit of one account and the credit of another. To illustrate this, let us assume that a merchant speculates in cotton, and purchases so many bales from John Bevan and Co. upon credit; he debits "Cotton account," and credits "John Bevan and Co." He does not pay for it in cash, but gives his bill at three months for the amount; John Bevan and Co. are debited with the bill, and "Bills Payable" are credited. He then sells the whole lot of cotton for cash to Cairns, Brown, and Co., debiting "Cash" and crediting "Cotton account." Lastly, he retires or pays the bill granted to John Bevan and Co., debits "Bills Payable," and credits "Cash." We will now put all these transactions into a "journal," posting therefrom to a "ledger," and so illustrate book-keeping by double entry.

Dates.	Journal.	*Dr.* £	s.	d.	*Cr.* £	s.	d.
1875.							
June 4	Cotton Account..	2349	0	0			
,,	To John Bevan and Co., Charleston..................................	..			2349	0	0
	For Bales, @ , ex "Mary Jane."						
June 6	John Bevan and Co..	2349	0	0			
,,	To Bills Payable..	..			2349	0	0
	For our acceptance, No. 136, @ 3m/., due 6/9 Sept., at County Bank.						
June 17	Cash Account..	3200	0	0			
,,	To Cotton Account..				3200	0	0
	For Bales, @ , sold to Cairns, Brown, and Co., Manchester.						
Sept. 9	Bills Payable..	2349	0	0			
,,	To Cash..	...			2349	0	0
	For Bill, No. 136, retired at County Bank.						
Sept. 30	Cotton Account..	851	0	0			
,,	To Profit and Loss Account..	...			851	0	0
	For Profit on Cotton, ex "Mary Jane."						
		11,098	0	0	11,098	0	0

LEDGER ACCOUNTS.

Dr. COTTON ACCOUNT. **Cr.**

		£	s.	d.			£	s.	d.
1875. June 4	To J. Bevan and Co., for Bales, *ex* "Mary Jane"........	2349	0	0	1875. June 17	By Cash for Bales, sold to Cairns, Brown, and Co..................	3200	0	0
Sept. 30	,, Profit and Loss, for gain..............	851	0	0					
		3200	0	0					

Dr. JOHN BEVAN AND CO., Charleston. **Cr.**

		£	s.	d.			£	s.	d.
1875. June 6	To Bills payable, No. 136, due 6/9 Sept., County Bank............	2349	0	0	1875. June 4	By Cotton, per "Mary Jane," Bales, @	2349	0	0

Dr. BILLS PAYABLE. **Cr.**

		£	s.	d.			£	s.	d.
1875. Sept. 9	To Cash, No. 136, retired..................	2349	0	0	1875. June 6	By John Bevan and Co., No. 136, due 6/9 Sept., County Bank........	2349	0	0

Dr. CASH ACCOUNT. **Cr.**

		£	s.	d.			£	s.	d.
1875. June 17	To Cotton Account, Cairns, Brown, and Co.	3200	0	0	1875. Sept. 9	By Bills payable, No. 136, retired at County Bank...........	2349	0	0
					,, 30	Balance	851	0	0
							3200	0	0

Dr. PROFIT AND LOSS. **Cr.**

		£	s.	d.			£	s.	d.
					1875. Sept. 30	By Gain on Cotton, *ex* "Mary Jane"..	851	0	0

Dr. BALANCE SHEET, 30th September, 1875. **Cr.**

		£	s.	d.			£	s.	d.
	To Cash in hand..........................	851	0	0		By P. and L................................	851	0	0

It may be alleged that there are many unnecessary entries, involving too much trouble and waste of time, in bringing out the above results; but upon examination of the several accounts the great simplicity and utility of double entry is evident. For instance, "Cotton" account shows the actual result of the speculation per "Mary Jane;" "John Bevan and Co.'s" account exhibits the whole transaction with them, and how it was settled; "Bills Payable" account at once shows that the cotton bill is retired or paid; and "Cash" account declares a balance of £851 in cashier's hands, being the actual profit on the cotton, as further shown in "Profit and Loss" account.

An infinity of examples might be *given*, but the above will be a sufficient illustration. A *brief* outline, however, of the principal books required in this system may be introduced.

1. The CASH BOOK.—In this most important book *every cash* transaction must be entered of its proper date, and under its distinctive ledger heading, so as to give facility in journalizing; any balance thereon must be *cash* in hand, and should agree with the balance on "Cash account" in the ledger.

2. The DAY *or* WASTE BOOK.—This book records the daily transactions of every description in the rough, which, when properly arranged and *classified*, are written into the journal, and posted from thence to the ledgers.

3. The JOURNAL.—This may be called the mainspring of the system, and is *sometimes* called the "*posting medium*," as in it every transaction of *the* business is properly *recorded* before being again distributed *into* the ledger. There are *several* forms of journal, but the simplest and best is that of which a specimen has been given, with the addition of a column for the *insertion* of ledger folios when posted. *It* will be observed that the *debit* entries are in one column and the *credit* entries in *another*; if, therefore, the summations of these agree, and the entries *therein* embraced are correctly posted to the debit and credit *of accounts* in the ledger, the double entry is correct, and the books of the concern, no matter how multitudinous the entries may be, must come to a true balance.

4. The LEDGERS.—These are important books, as they are the final recipients of every transaction of the concern, branched out or distributed into certain heads or accounts which tell their own history; and if unbalanced, must exhibit a difference either in favour of the business as an "Asset," or against it as a "Liability." The usual plan is to have only *one* ledger, embracing every account, but in large concerns there are debit and credit ledgers, and generally a private ledger, which is accessible to partners only.

The advantages of double entry are many—(1.) Unless the debit balances exactly correspond with the credits the books are wrong, and the error must be discovered by comparison; (2.) The discovery of such errors is more easily *accomplished* than in any other system; (3.) Accounts can be readily analyzed; and (4.) The profit or loss on *distinct* transactions can be ascertained without difficulty. The disadvantages are—(1.) More *manual* labour required in transcribing the journal and posting therefrom than *in* other systems; and (2.) There is not the same privacy, as profits and losses can be seen at a glance by any one having access to the ledger. Nevertheless, no other system as yet devised can at all compare with that by double entry.

III. MIXED METHOD.—This system is now extensively adopted by such *companies* and firms as begrudge the time expended in journalizing, and are of opinion that double entry is too elaborate, when the same results can be arrived at by a more direct and less laborious *plan*. There is this identity, however, between the systems, that every transaction must be recorded *somewhere*, and eventually twice posted, as in double entry, *but* without the medium of a journal; moreover, the entries are fewer, summations and not specific items being *posted*, and what would be the daily labour under one system is reserved under this for a monthly or perhaps *longer* period. There are only three books required for this system to which we need draw attention, and in doing so we will point out in what respect they differ from those kept in single and double entries.

1. Cash Book.—Every entry is posted from this book, but not all to the ledger as in double entry—"Charges" being posted to the day book. It is not journalized, and is in itself a ledger, as it contains the bank account, and reports its own cash balance. On the other hand, it is unlike the "Cash" of single entry, because every entry is posted somewhere, whereas by the latter system only personal accounts are carried to the ledger.

2. Day Book.—This book also exhibits a marked difference between the journal of double entry and the day book of single entry. The journal is simply a posting medium, and when its use is served is almost valueless. The single entry day book, on the other hand, is only a posting medium to a certain extent, as it does not embrace all transactions; but in this system the day book unites the characteristics of journal and ledger, and also becomes in itself a profit and loss account, as by deducting the amount of charges from the amount of the business fees (say for solicitors' books) *the profit on said business is shown.*

3. The Ledgers.—These books also lose their completeness under the mixed method. It has already been shown that in double entry every amount must appear in the ledger, and in single entry that only personal accounts are posted in it. By this system not only are all personal accounts included, but those applicable to "Capital," to "Banks," "Bills," &c.; whilst, on the other hand, such accounts as "Profit and Loss," "Charges," and "Cash" are excluded.

It would be out of place here to dwell on the many intricacies of this subject, or on the difficulties which are constantly presenting themselves even to the most practical men. With a thorough knowledge of the art, however, and that patience and perseverance so essential to the calling of a book-keeper, the gravest impediments are overcome, and everything becomes simple and plain. Our sole object having been to show the utility of book-keeping as a science, and the peculiar features of existing systems with their advantages and disadvantages, it is unnecessary to enter more minutely into details by describing subsidiary books or forms of accounts, as these are only so many materials out of which the fabric of book-keeping is erected, and can be seen in any counting-house or mercantile establishment where regular systems are adopted. (F. H. C.)

BOOLE, George, one of the most original logicians and mathematicians whom England has produced, was born in Lincoln on the 2d of November 1815. His father was a tradesman of limited means, but of studious character and active mind. Being especially interested in mathematical science the father gave his son early instruction in the rudiments of the science he was so greatly to advance; but it is remarkable that the extraordinary mathematical powers of George Boole did not manifest themselves in early life. The classical languages formed at first the favourite subject of his studies. Not until the age of seventeen years did he attack the higher mathematics, and his progress was much retarded by the want of efficient help.

When about sixteen years of age he became assistant-master in a private school at Doncaster, and he maintained himself to the end of his life in one grade or other of the scholastic profession. Few distinguished men, indeed, have had a less eventful life. Almost the only changes which can be called events are his successful establishment of a school at Lincoln, its removal to Waddington, his appointment in 1849 as professor of mathematics in the Queen's College at Cork, and his marriage in 1855 to Miss Mary Everest.

To the public Boole was known only as the author of numerous abstruse papers on mathematical topics, and of three or four distinct publications which have become standard works. His earliest published paper was one upon the "Theory of Analytical Transformations," printed in the *Cambridge Mathematical Journal* for 1839, and it led to a friendship between Boole and D. F. Gregory, the editor of the journal, which lasted until the premature death of the latter in 1844. A long list of Boole's memoirs and detached papers, both on logical and mathematical topics, will be found in the *Catalogue of Scientific Memoirs* published by the Royal Society, and in the supplementary volume on *Differential Equations*, edited by Mr Todhunter. To the *Cambridge Mathematical Journal* and its successor, the *Cambridge and Dublin Mathematical Journal*, Boole contributed in all twenty-two articles. In the third and fourth series of the *Philosophical Magazine* will be found sixteen papers. The Royal Society printed six important memoirs in the *Philosophical Transactions*, and a few other memoirs are to be found in the *Transactions of the Royal Society of Edinburgh* and of the *Royal Irish Academy*, in the *Bulletin de l'Académie de St Pétersbourg* for 1862 (under the name G. Boldt, vol. iv. pp. 198–215), and in *Crelle's Journal*. To these lists should be added a paper on the mathematical basis of logic, published in the *Mechanic's Magazine* for 1848. The works of Boole are thus contained in about fifty scattered articles and a few separate publications.

Only two systematic treatises on mathematical subjects were completed by Boole during his lifetime. The well-known *Treatise on Differential Equations* appeared in 1859, and was followed, the next year, by a *Treatise on the Calculus of Finite Differences*, designed to serve as a sequel to the former work. These treatises have become the standard text-books on the important branches of mathematics in question, and Boole, in composing them, seems to have combined elementary exposition with the profound investigation of the philosophy of the subject in a manner hardly admitting of improvement. To a certain extent these works embody the more important discoveries of their author. In the 16th and 17th chapters of the *Differential Equations* we find, for instance, a lucid account of the general symbolic method, the bold and skilful employment of which led to Boole's chief discoveries, and of a general method in analysis, originally described in his famous memoir printed in the *Philosophical Transactions* for 1844. Boole was one of the most eminent of those who perceived that the symbols of operation could be separated from those of quantity and treated as distinct objects of calculation. His principal characteristic was perfect confidence in any result obtained by the treatment of symbols in accordance with their primary laws and conditions, and an almost unrivalled skill and power in tracing out these results.

During the last few years of his life Boole was constantly engaged in extending his researches with the object of producing a second edition of his *Differential Equations* much more complete than the first edition; and part of his last vacation was spent in arduous study in the libraries of the Royal Society and the British Museum for the purpose of acquiring a complete knowledge of the less accessible original memoirs on the subject. It must be always a matter of regret that this new edition was never completed. Even the manuscripts left at his death were so incomplete that Mr Todhunter, into whose hands they were put, found it impossible to use them in the publication of a second edition of the original treatise, and wisely printed them, in 1865, in a supplementary volume.

Profound and important as were Boole's discoveries in pure mathematics, his writings on logic may be considered as still more original. With the exception of De Morgan, he was probably the first English mathematician since the time of Wallis who had also written upon logic; and his wholly novel views of logical method were due to the same profound confidence in symbolic reasoning to which he had successfully trusted in mathematical investigation. From the preface to his *Mathematical Analysis of Logic*, printed as a separate tract in 1847, we learn that speculations concerning a calculus of reasoning had at different times occupied Boole's thoughts, but it was not till the spring of 1847 that a memorable logical controversy led him to put his ideas into a definite form. Boole afterwards regarded this pamphlet as a hasty and imperfect exposition of his

logical system, and he desired that his much larger work, *An Investigation of the Laws of Thought, on which are founded the Mathematical Theories of Logic and Probabilities*, published in 1854, should alone be considered as containing a mature statement of his views. Nevertheless, there is a charm of originality about his earlier logical work which no competent reader can fail to appreciate, and the introduction gives striking evidence of his profound views and wide reading.

It is not easy to give in a few words a correct notion of Boole's logical system, and only those who are conversant with the principles of symbolical reasoning can exactly apprehend his position. He did not regard logic as a branch of mathematics, as the title of his earlier pamphlet might be taken to imply, but he pointed out such a deep analogy between the symbols of algebra and those which can be made, in his opinion, to represent logical forms and syllogisms, that we can hardly help saying that logic is mathematics restricted to the two quantities, 0 and 1. By unity Boole denoted the universe of thinkable objects; literal symbols, such as x, y, z, v, u, &c., were used with the elective meaning attaching to common adjectives and substantives. Thus, if x = horned, and y = sheep, then the successive acts of election represented by x and y, if performed on unity, give the whole of the class *horned sheep*. Boole showed that elective symbols of this kind obey the same primary laws of combination as algebraical symbols, whence it followed that they could be added, subtracted, multiplied, and even divided, almost exactly in the same manner as numbers. Thus, $1-x$ would represent the operation of selecting all things in the world except *horned things*, that is, *all not horned things*, and $(1-x)(1-y)$ would give us *all things neither horned nor sheep*. By the use of such symbols propositions could be reduced to the form of equations, and the syllogistic conclusion from two premises was obtained by eliminating the middle term according to ordinary algebraic rules.

Still more original and remarkable, however, was that part of his system, fully stated in his *Laws of Thought*, which formed a general symbolic method of logical inference. Given any propositions involving any number of terms, Boole showed how, by the purely symbolic treatment of the premises, to draw any conclusion logically contained in those premises. The second part of the *Laws of Thought* contained a corresponding attempt to discover a general method in probabilities, which should enable us from the given probabilities of any system of events to determine the consequent probability of any other event logically connected with the given events. Soon after its publication this method was the subject of a controversy in the *Philosophical Magazine*; but it cannot be said that the exact value of this part of his works has ever been clearly ascertained.

It is often supposed that mathematicians are deficient in judgment and knowledge of other matters. In Boole this was not the case; for though he published little except the mathematical and logical works already mentioned, his acquaintance with general literature was wide and deep. Dante was his favourite poet, and he preferred the *Paradiso* to the *Inferno*. The metaphysics of Aristotle, the ethics of Spinoza, the philosophical works of Cicero, and many less celebrated works of a kindred character, were also frequent subjects of study. His reflections upon scientific, philosophical, and religious questions are to be mainly gathered from four addresses upon *The Genius of Sir Isaac Newton*, *The Right Use of Leisure*, *The Claims of Science*, and *The Social Aspect of Intellectual Culture*, which he delivered and printed at different times.

The personal character of Boole inspired all his friends with the deepest esteem. He was marked by the modesty of true genius, and his life was given to the single-minded pursuit of truth. Though he received a royal medal for his memoir of 1844, and the honorary degree of LL.D. from the University of Dublin, it may be said that he neither sought nor received the ordinary rewards to which his discoveries would entitle him.

On the 8th of December 1864, in the full vigour of his intellectual powers, Boole died of an attack of fever, ending in suffusion on the lungs An excellent sketch of his life and works, by the Rev. R. Harley, F.R.S., to which the present writer is indebted for many particulars, is to be found in the *British Quarterly Review* for July 1866, No. 87. (W. S. J.)

BOOM, a town of Belgium, in the province of Antwerp, and 12 miles S. of that city, at the junction of the Brussels Canal with the River Rupel. It is an active industrial town, possessing tanneries, salt-works, starch-factories, breweries, and brick and tile works, and carries on a considerable trade. Population of the commune, 10,064.

BOOMERANG, a missile instrument of the Australian aborigines, in the use of which they are very dexterous. It consists of a piece of hard wood, with the curve of a parabola, and is about 2 feet long, $2\frac{1}{2}$ inches broad, $\frac{1}{3}$ inch thick, and rounded at the extremities. One side is flat, the other is rounded, and it is brought to a bluntish edge. It is discharged with the hand by one end, the convex edge being forward and the flat side upwards. After advancing some distance, and ascending slowly in the air with a quick rotatory motion, it begins to retrograde, and finally falls to the ground behind the thrower. A weapon of similar form, but wanting the return flight, has been found in use among savage tribes both in India and Africa. A very full comparative account of the boomerang is contained in Colonel A. H. Lane Fox's lecture on "Primitive Warfare" (*Jour. of the Royal United Service Institution*, vol. xii. No. 51).

BOOTH, BARTON, an English tragedian, descended from an ancient family in Lancashire, was born in 1681. He was educated at Westminster school under the celebrated Dr Busby, and his success in the Latin plays, customarily performed there by the scholars, gave him an inclination for the stage. He was intended for the church; but at seventeen years of age he ran away from school, and after some vicissitudes obtained employment in a theatrical company in Dublin. His first appearance was hailed with applause; and he continued to improve daily. After two successful campaigns in Ireland he returned to his native country, having first reconciled himself to his friends. Betterton, to whom he had an introduction, received him with great cordiality, and gave him all the assistance in his power. His success at London was complete, and he established his reputation as only second to his great instructor. He was indebted to a happy coincidence of merit and chance for the celebrity which he at length attained in the character of Cato. The Whigs, in favour of whose principles Addison's tragedy had been written, thought it their duty to support it strongly; while the Tories, at every passage susceptible of a popular turn, were no less vehement in their approbation, and at the close the actor was presented by Lord Bolingbroke with a purse of fifty guineas, "as a slight acknowledgment of his honest opposition to a perpetual dictator, and his dying so bravely in the cause of duty." Booth was twice married,—first to a daughter of Sir William Barkham, Bart., and afterwards to Miss Hester Santlow, an actress of great merit. During the twenty years of his management the theatre was in the greatest credit; and his death, which happened on the 10th of May 1733, contributed not a little to its decline. Booth was a man of excellent character, and greatly esteemed for his amiability and goodness of heart.

(*See Memoirs of the Life of Barton Booth*, 1733; Cibber, *Lives and Characters of the most Eminent Actors*, &c., pt. i., 1753.)

BOOTHIA FELIX, a peninsula of British North America, between lat. 69° and 72° N., and long. 92° and 97° W. It was discovered by Captain (afterwards Sir James) Ross, in 1830, and was named after Sir Felix Booth, who had fitted out the expedition. It forms the western side of the gulf of the same name into which Prince Regent's Inlet leads from Baffin's Bay. From the American shore it is almost separated by lakes and inlets; and a narrow channel known as Bellot Strait intervenes between it and North Somerset Island, which was discovered by Sir E. Parry in 1819. The peninsula is not only interesting for its connection with the Franklin expedition and the Franklin search, but is of scientific importance from the north magnetic pole having been first distinctly localized there by Ross.

BOPP, Francis, glottologist, was born at Mainz on the Rhine, September 14, 1791. In consequence of the political troubles of that time, his parents removed to Aschaffenburg, in Bavaria, where Francis received a liberal education at the Lyceum. It was here that his attention was drawn to the languages and literature of the East by the eloquent lectures of Carl J. Windischmann, who, with Creuzer, Görres, and the brothers Schlegel, was full of enthusiasm for Indian wisdom and philosophy. And further, Fr. Schlegel's book, *Ueber die Sprache und Weisheit der Inder* (Heidelberg, 1808), which was just then exerting a powerful influence on the minds of German philosophers and historians, could not fail to stimulate also Bopp's interest in the sacred language of the Hindus. He was, however, too strictly trained in grammatical and philological studies, and too eager for the scientific analysis of language, to allow the clearness of his judgment to be warped by the romantic and speculative predilections of Windischmann and Fr. Schlegel. In 1812 he went to Paris at the expense of the Bavarian Government, with a view to devote himself vigorously to the study of Sanskrit. There he enjoyed the society of such eminent men as Chézy, S. de Sacy, Langlès, and, above all, Al. Hamilton, who had acquired, when in India, a respectable acquaintance with Sanskrit, and had brought out, conjointly with Langlès, a descriptive catalogue of the Sanskrit manuscripts of the Imperial library. At that library Bopp had access not only to the rich collection of Sanskrit manuscripts, most of which had been brought from India by Father Pons early in the 18th century, but also to the Sanskrit books which had up to that time issued from the Calcutta and Serampore presses.

The first fruit of his four years' study in Paris appeared at Frankfort-on-the-Main in 1816, under the title *Ueber das Conjugationssystem der Sanskritsprache in Vergleichung mit jenem der Griechischen, Lateinischen, Persischen, und Germanischen Sprache*, and it was accompanied with a preface from the pen of Windischmann, bearing date 16th May of that year. In this first book, Bopp entered at once on the path on which the philological researches of his whole subsequent life were concentrated. It was not that he wished to prove the common parentage of Sanskrit with Persian, Greek, Latin, and German, for that had long been established; but his object was to trace the common origin of their grammatical forms, of their inflexions from composition,—a task which had never been attempted. By a historical analysis of those forms, as applied to the verb, he furnished the first trustworthy materials for a history of the languages compared.

After a brief sojourn in Germany, Bopp came to London, where he made the acquaintance of Wilkins and Colebrooke, and became the friend of Wilhelm von Humboldt, then Prussian ambassador at the court of St James's, to whom he gave instruction in Sanskrit. He brought out, in the *Annals of Oriental Literature* (London, 1820, pp. 1-65), an essay entitled "Analytical Comparison of the Sanskrit, Greek, Latin, and Teutonic Languages," in which he extended to all parts of the grammar what he had done in his first book for the verb alone. He had previously published a critical edition, with a Latin translation and notes, of the story of *Nala and Damayanti* (London, 1819), the most beautiful episode of the Mahâbhârata, which he had with genial tact culled from the tangled labyrinth of that gigantic epic. Other episodes of the Mahâbhârata—*Indralokâgamanam*, and three others, Berlin, 1824; *Diluvium*, and three others, Berlin, 1829; and a new edition of *Nala*, Berlin, 1832—followed in due course, all of which, with A. W. Schlegel's edition of the *Bhagavadgîtâ*, 1823, proved excellent aids in initiating the early student into the reading of Sanskrit texts. On the publication, in Calcutta, of the whole Mahâbhârata, Bopp discontinued editing Sanskrit texts, and confined himself thenceforth exclusively to grammatical investigations.

After a short residence at Göttingen, Bopp was, on the recommendation of W. von Humboldt, appointed to the chair of Sanskrit and comparative grammar at Berlin in 1821, and was elected member of the Royal Prussian Academy in the following year, both which posts he held up to his death, Oct. 23, 1867. In his quality as Sanskrit professor he brought out, in 1827, his *Ausführliches Lehrgebäude der Sanskrita-Sprache*, on which he had been engaged since 1821. A new edition, in Latin, was commenced in the following year, and completed in 1832. A shorter grammar (*Kritische Grammatik der Sanskrita-Sprache in kürzerer Fassung*) has run through three editions (Berlin, 1834, 1845, 1863). At the same time he compiled a Sanskrit and Latin glossary (1830) in which, more especially in the second and third editions (1847 and 1867), account has also been taken of the cognate languages. His chief activity, however, centred on the elaboration of his *Comparative Grammar*, which appeared in six parts at considerable intervals (Berlin, 1833, 1835, 1842, 1847, 1849, 1852; 1511 pages in small 4to), under the title *Vergleichende Grammatik des Sanskrit, Zend, Griechischen, Lateinischen, Litthauischen, Altslavischen, Gothischen, und Deutschen.* How carefully this work was matured may be gathered from the series of monographs printed in the *Transactions of the Berlin Academy* (1824 to 1831), by which it was preceded. They bear the general title, *Vergleichende Zergliederung des Sanskrits und der mit ihm verwandten Sprachen.* Two other essays (on the "Numerals," 1835) followed the publication of the first part of the *Comparative Grammar.* The Old-Slavonian began to take its stand among the languages compared from the second part onwards. At the instance of the earl of Ellesmere (then Lord Francis Egerton) the work was translated into English by Mr E. B. Eastwick (3 vols., 1845; second edition, 1854). A second German edition, thoroughly revised (3 vols., 1856–1861), comprised also the Old-Armenian. From this edition an excellent French translation was made by Professor Michel Bréal, which came out in 5 vols. in 1866, *ff.* A third German edition has been published since the author's death, in 1871, *ff.*

The task which Bopp endeavoured to carry out in his *Comparative Grammar* was threefold,—to give a description of the original grammatical structure of the languages as deduced from their intercomparison, to trace their phonetic laws, and to investigate the origin of their grammatical forms. The first and second points were subservient to the third. As Bopp's researches were based on the best available sources, and incorporated every new item of information that came to light, so they continued to widen and deepen in their progress. Witness his monographs on the vowel system in the Teutonic languages (1836), on the Celtic

languages (1839), on the Old-Prussian (1853) and Albanian languages (1854), on the accent in Sanskrit and Greek (1854), on the relationship of the Malayo-Polynesian with the Indo-European languages (1840), and on the Caucasian languages (1846). In the two last-mentioned the impetus of his genius had led him on a wrong track. They show the rocks against which the student of comparative philology has to guard.

As for the charge that has been made against Bopp of neglecting the study of the native Sanskrit grammars, every excuse ought to be made in his favour. In those early days of Sanskrit studies the requisite materials were not accessible in the great libraries of Europe; and if they had been, they would have absorbed his exclusive attention for years, while the grammars of Forster, Wilkins, and Colebrooke, from which his grammatical knowledge was derived, were all based on native grammars. The further charge that Bopp, in his *Comparative Grammar*, gave undue prominence to Sanskrit may be disproved by his own words; for, as early as the year 1820, he gave it as his opinion that frequently the cognate languages serve to elucidate grammatical forms lost in Sanskrit (*Annals of Or. Lit.*, i. 3),—an opinion which he has further developed in all his subsequent writings. In his translations from the Sanskrit Bopp was not successful. He seems to have felt this himself; for, after the publication, in 1838, of his metrical translation of the *Story of Nala*, he resigned that task to more skilful hands.

The method of tracing the life and growth of language, so successfully applied by Bopp in the case of the Indo-European languages, has become the corner stone on which all modern linguistic science rests. His researches, carried with wonderful penetration into the most minute and almost microscopical details of linguistic phenomena, have led to the opening up of a wide and distant view into the original seats, the closer or more distant affinity, and the tenets, practices, and domestic usages of the ancient Indo-European nations, and form the only safe basis on which further investigations in each direction are possible. The outlines of his great work had been distinctly traced by him in his very first publication, from which the science of comparative grammar may truly be said to date. In grateful recognition of that fact, on the fiftieth anniversary of the date of Windischmann's preface to that work, a fund called *Die Bopp-Stiftung*, for the promotion of the study of Sanskrit and comparative grammar, was established at Berlin, to which liberal contributions were made by his numerous pupils and admirers in all parts of the globe.

Bopp was specially favoured by fortune in living to see the results of his labours everywhere accepted, and his name justly celebrated. But the sun that gilds the writer's pen did not shine upon him, and he died a poor man,—by his genuine kindliness and unselfishness, his devotion to his family and friends, and his rare modesty, endeared to all who knew him. (*Bréal's Translation of Bopp's Comp. Gr.*, vol. i., introduction; Th. Benfey, *Geschichte der Sprachwissenschaft*, 1869; A. Kuhn in *Unsere Zeit*, Neue Folge, iv. 1, 1868.)

BORAX, the biborate of sodium ($Na_2B_4O_7$), a substance found in commerce under the two different forms of ordinary or prismatic borax, which contains ten equivalents of water of crystallization, and octahedral or jeweller's borax, which has only five molecules of water in its composition. The former, which is the variety commonly met with, occurs as a natural product in various parts of the world. In former times crude borax was procured chiefly from Thibet, whence it came by way of India under the name of tincal. It also is found in other parts of Central Asia, at Halberstadt in Transylvania, in Canada, and in Peru; and in recent years an important source of the mineral has been discovered near the Clear Lake in California, in a body of water now called the Borax Lake. In very dry seasons the water almost entirely disappears from the basin of the Borax Lake, which is situated in a region containing hot springs and the remains of volcanic action. In 1863, when the lake measured 4000 feet long, 1800 feet across at its widest part, and about 3 feet deep, the water was found to contain 2401·56 grains of solid matter per gallon, of which 535·08 grains represented crystallized borax. The bed of the lake is occupied with a deposit of borax crystals, which are obtained by sinking caissons, pumping out the water, and digging up the deposit. Californian crude borax is fit for use by assayers and others without undergoing any purification; but that obtained from Thibet contains a greenish encrusting matter of a soapy consistence which has to be separated before the material is fit for use under the name of refined borax.

The supply of borax is, however, more largely derived by artificial means from boracic or boric acid, or from salts in which that acid occurs, than from these natural sources. Boracic acid is found among the ejecta around the craters of some volcanoes, and it is found in jets of vapour which stream forth from fissures in the earth in regions of volcanic disturbance. The chief source of boracic acid at the present day is found in the Maremma of Tuscany, an extensive and desolate track of country embracing an area of about forty miles, over which jets of vapour and heated gases (*soffioni*) and springs of boiling water spurt out from numerous chasms and fissures. The Maremma is disturbed by frequent volcanic shocks; at some points the mouths of the fissures open direct into the air, at others they are covered by small muddy lakes (*lagoni*). In addition to a small impregnation of boracic acid the soffioni contain ammoniacal vapour, to fix and obtain which the gases at some works are led through sulphuric acid. For obtaining the boracic acid a series of basins or artificial lagoni are formed over the soffioni, so arranged that water to be charged with the acid is conveyed by gravitation from the first to the last of the series. Water is led into the highest and by the action of the heated gases it is soon in a state of ebullition. After being so left for about a day it is drawn off into the second, where it remains under like circumstances for the same period, and so to the end of the series, when the water should contain nearly 2 per cent. of boracic acid. The mechanical impurities being allowed to subside, the liquor is then run into evaporating pans, shallow lead-lined vessels, heated by the gases from the soffioni themselves. The evaporating pans are worked on a continuous system, similar to the lagoons; the liquor placed in the upper being concentrated down to half its original bulk is run into the second, and so on till it reaches a degree of concentration fit for crystallizing out the acid. In recent years artificial soffioni have been formed by boring through the rock till some of the numerous chasms or chambers, with which the interior is honey-combed, are reached, when immediately all the phenomena of a boracic soffione are established. From some of these artificial soffioni issues water of sufficient richness in acid to be led there direct to the evaporating pans. Similar emanations of volcanic vapours and boracic acid have been discovered in Nevada, United States. Boracic acid is also obtained from boronatrocalcite (Ulexite or Hayesine), a double salt of sodium and calcium, of which extensive deposits exist in the neighbourhood of the nitrate of soda beds of Chili and Peru. It is very variable in constitution and condition of purity. Similar deposits are found in California, Nevada, and Nova Scotia, and from the West Coast of Africa is received a borate of lime bearing the name of rhodizite. The boronatrocalcite, or borate of lime, as it is called in commerce, is applied in its unrefined condition

to many uses for which borax is employed. In 1855 Dr T. Richardson patented a process for using the picked and washed boronatrocalcite as a substitute for borax in the glass manufacture and preparation of pottery glazes. It is, however, chiefly employed as a source of boracic acid, and there are also several methods of obtaining borax direct from the compound salt.

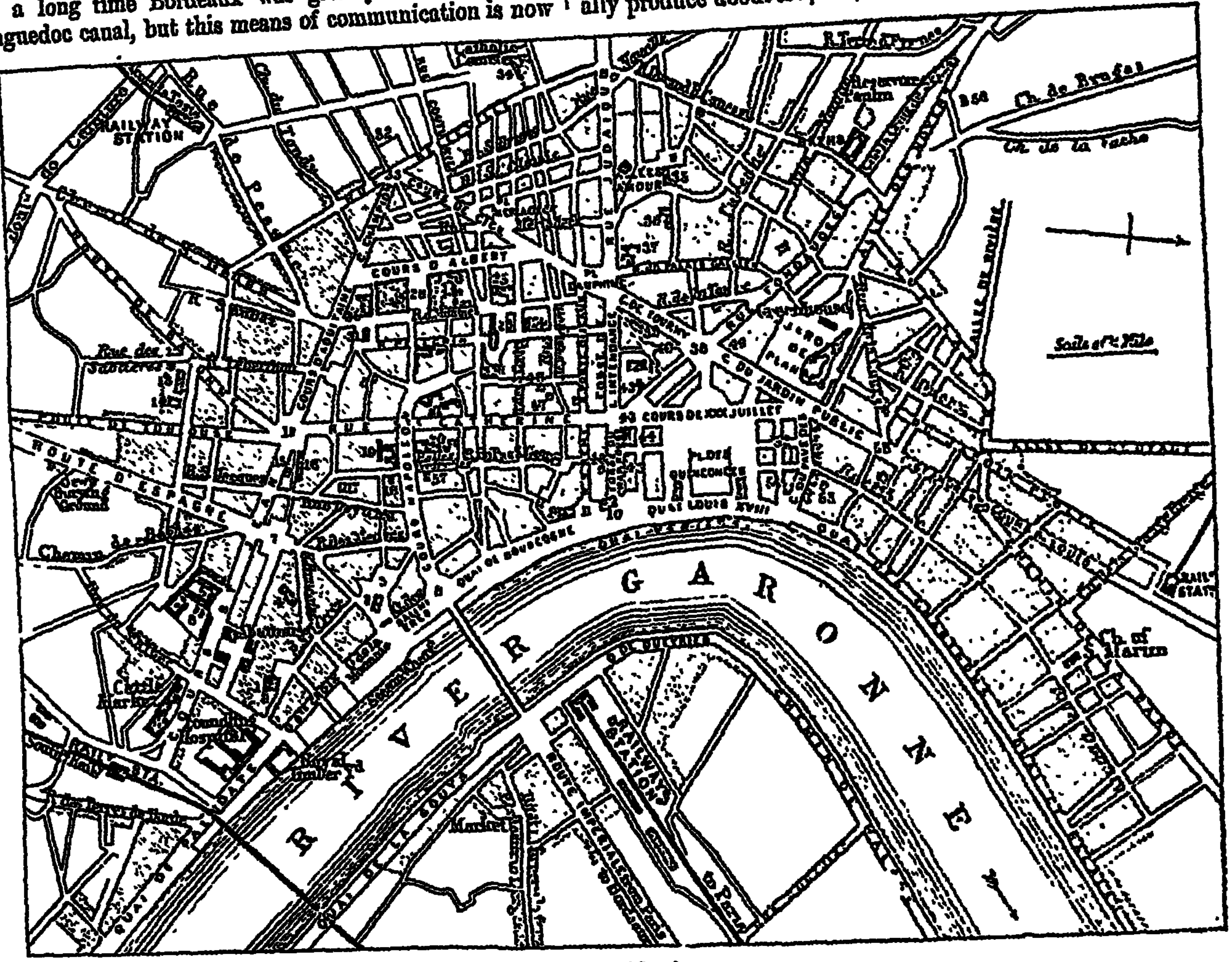
Commercial boracic acid usually contains a considerable percentage of sulphates of ammonium, magnesium, and calcium besides other impurities. To prepare borax from this acid, from 110 to 120 parts of crystallized sodium carbonate are required for 100 parts of boracic acid. The soda is dissolved in a lead-lined vessel heated with steam, to which the boracic acid is added in repeated charges. The vessel is covered and the carbonate of ammonia given off is led into a solution of sulphuric acid and fixed. For the production of ordinary or prismatic borax the solution is brought to a strength of 20° to 22° Baumé (1·161 to 1·180 sp. gr.) and allowed to cool down as slowly as possible, so that the crystals may assume the large size demanded in commerce. Octahedral borax is deposited when a solution indicating 30° Baume (sp. gr. 1·264) is slowly cooling down from 79° to 56° C. Below this point the formation of ordinary borax takes place.

Under the blowpipe borax parts with its water, and melts into a clear-glass which has the peculiar property of dissolving many metallic oxides, and thereby exhibiting characteristic colours, on which account it is of great value in blowpipe analysis. The same property also renders it a valuable material for pottery glazes and enamels, and as it adheres closely to clean surfaces of metal and prevents their oxidation under high heat, it is indispensable for use in hard soldering, and is largely employed in brass manufactures. It is also one of the ingredients employed in glass-making. Borax forms with oils and fats a soap which has been proposed as a detergent; but experiments conducted by the late Professor Thomas Anderson of Glasgow show that it has a more corrosive influence on fibres than common soap. In Belgium powdered borax is used in domestic washing, with the object of economizing soap. Borax is used in medicine as an external application in skin diseases, and the preparation known as *mel boracis* is a useful gargle in ulceration of the mouth and throat. In Sweden boracic acid is extensively employed for the preservation of meat and milk; and while it forms an efficient antiseptic, food prepared with it is said to be perfectly fit for use. A very beautiful pigment, now much used in calico-printing, under the name of Guignet's green, is a borate of chromium.

BORDA, JEAN CHARLES, mathematician and nautical astronomer, was born at Dax on the 4th May 1733. He studied at La Flèche, and at an early age obtained a commission in the cavalry. In 1756 he presented a valuable paper to the Academy of Sciences, who elected him a member. He was present at the battle of Hastembeck, and soon afterwards joined the naval service. He visited the Azores and the Canary Islands, of which he constructed an admirable map. In 1782 his frigate was taken by a British squadron; he himself was carried to England, but was almost immediately released on parole, and returned to France. He died on the 20th February 1799. Borda was an admirable mathematician, and contributed a long series of valuable memoirs to the Academy of Sciences. His researches in hydrodynamics were highly useful for marine engineering, while the reflecting and repeating circles, as improved by him, were of great service in nautical astronomy. He was associated with Delambre and Méchain in the attempt to determine an arc of the meridian, and the greater number of the instruments employed in the task were invented by him. (See Biot, "Notice sur Borda" in the *Mém. de l'Acad. des Sciences*, iv.)

BORDEAUX, one of the finest and wealthiest commercial cities of France, formerly the capital of Guienne and Bordelais, and now the chief town of the department of Gironde. It is situated 370 miles S.E. of Paris, in 44° 50′ N. lat. and 0° 25′ W. long., on the left bank of the Garonne, about 60 or 70 miles from its mouth, and in the midst of an extensive plain which comprises the district of Médoc, well-known for its red wines. Opposite the town the river makes a semicircular curve, and widens out into an extensive basin, which serves as a harbour, and is lined with quays on both sides for a distance of three miles. Vessels of 800 tons can come up to the town, and ships of the greatest ordinary tonnage have depth enough as far as Pauillac, about 35 miles from the mouth of the river. The basin is crossed by a magnificent stone bridge of 17 arches, 1534 feet long, which was built in 1821, and remained in the hands of a company till 1861 when it was declared free. A short distance further up the river is spanned by a railway bridge. Few cities in Europe can show such a striking water-front as Bordeaux; and though the streets of the older part are narrow and mean, those of the newer portions are wide and well paved, and contain handsome houses and public buildings. The principal square is the Place des Quinconces, which is adorned with statues of Montaigne and Montesquieu. Among the ecclesiastical buildings the most important are the cathedral of Saint André, a fine Gothic structure with two spires 160 feet high; the church of Saint Michel, founded in 1160, and formerly remarkable for a spire 319 feet in height, destroyed by a storm in 1768; Saint Croix, probably in existence before the 7th century, restored in 1864–5; Saint Paul, built by the Jesuits in 1676; and the church of the Collége Royal, in which is the tomb of Montaigne. The great intellectual activity of the city may be seen from the fact that it possesses an academy (with faculties of theology, law, science, and literature), a medico-pharmaceutical school, a lyceum, a school for deaf-mutes, a normal school, and a school of navigation; numbers among its societies an academy of sciences, arts, and belles lettres, a medical society (founded in 1798), an agricultural society, a philomathic, a Linnæan, a horticultural, and an archæological society; and maintains nine daily papers, about as many weeklies, and two or three monthly periodicals, besides the official publications of several of the above-mentioned societies. Its communal library, which dates from 1566, contains about 200,000 volumes; and it has also an antiquarian museum, a museum of natural history, and a picture gallery. Among its benevolent institutions are the hospital of Saint André, founded in 1825 to replace an older building of the same name, which dated from 1390, a children's hospital, originated in 1619, a hospital for incurables, a maternity and a military hospital, the lock hospital of Saint Jean, and a magnificent deaf and dumb asylum. Of theatres there are five,—the Grand Théâtre, finished in 1780 and seated for 1300; the Théâtre Louit, opened in 1868, for 2500; the Théâtre Français, dating from 1857, for 1300; the Théâtre National, opened in 1866, for 1000; and the Théâtre des Folies Bordelaises built in 1872. A few buildings are of merely antiquarian interest, the most important being the Palais Gallien, which is really an old Roman amphitheatre of the 3d century, and the tower of Pey Berland. Bordeaux is the seat of an archbishop, and has a court of appeal, a court of assize, and tribunals of primary instance and commerce. It has also a mint, the coinage of which is marked by the letter K. Its commercial institutions are necessarily numerous and varied; comprising an exchange, banks, insurance-offices, custom-

houses, public warehouses, and consulships of some forty different countries. The trade is very extensive, particularly in wines, and has undergone a remarkable development since the introduction of railways and steamships. For a long time Bordeaux was greatly indebted to the Languedoc canal, but this means of communication is now of minor importance. The total value of the export and import trade is annually about £16,500,000, about a third belonging to Britain. In 1872 the value of Bordeaux wines exported from France was upwards of £5,600,000, and the brandy and liqueurs from Bordeaux itself annually produce about £1,000,000. The other articles exported



Ground-Plan of Bordeaux.

1 Hospital for Old Men.
2 Church of St Michel
3 Place du Marché Neuf
4 Grand Séminaire.
5 Petit Séminaire.
6 Asylum for the Insane.
7 Place des Capuçins
8 Place Bourgogne
9. Custom House
10. Exchange.
11. Place de la Bourse.
12. Place d'Aquitaine
13. Military Hospital.
14. Church of St Nicholas.
15. St John's Hospital.
16. Hospital for Incurables.
17. Synagogue.
18. St James's Chapel.
19. Barracks.
20 Old Palais de Justice and St Paul's Church.
21. Lycée Impérial.
22 Old Chapelle des Irlandais.
23. St Andrew's (Cathedral)
24. Municipal Barracks.
25. Hôtel de Ville.
26. Prison Départemental.
27. Palais de Justice.
28. Place d'Armes.
29. St Andrew's Hospital.
30. St Raphael's Barracks
31. Church of St Eulalie.
32. Tobacco Manufactory.
33 Place Rodesse.
34. Church of St Bruno.
35. Church of St Seurin.
36. Deaf and Dumb Institution.
37. Mint.
38. Place de Tourny.
39. Théâtre des Variétés.
40. Place des Grands Hommes.
41. Church of Notre Dame.
42. Hôtel de l'Académie.
43. Place de la Comédie.
44 Grand Theatre.
45. Hôtel de la Préfecture
46. Old Church of St Rémi.
47. Chapelle de Notre Dame de Bon Secours.
48. Archbishop's Palace.
49. Hôtel de la Marine.
50. Church of the Carmelites.
51. Baths.
52. English Protestant Church.
53 Protestant Church.
54. Entrepôt réel.
55. Church of St Louis and Archives du Département.
56 Collège de Tivoli.
57 Church of St Eloi.
58. Place Fégère.

comprise corn, fruits, sugar, wood, resin, rags, madder, tartar, gums, indigo, and native manufactures. Shipbuilding is a leading industry, the number of firms in that department being about twenty in 1875. In the same year 220 vessels belonged to the port, with a total tonnage of upwards of 92,000 English tons.

Bordeaux, or *Burdigala*, was originally the chief town of the Bituriges Vivisci. Under the Roman empire it became a flourishing commercial city, and in the 3d century it was made the capital of Aquitania Secunda. Ausonius, a writer of the 4th century, who was a native of the place, describes it as four-square and surrounded with walls and lofty towers, and celebrates its importance as one of the greatest educational centres of Gaul. In the evils that resulted from the disintegration of the empire Bordeaux had its full share, and did not recover its prosperity till the beginning of the 10th century. Along with Guienne it belonged to the English kings for nearly three hundred years (1154–1452), and was for a time the seat of the brilliant court of the Black Prince, whose son Richard was born in the city. An extensive commerce was gradually developed between the Bordeaux merchants and their fellow-subjects in England,—London, Hull, Exeter, Dartmouth, Bristol, and Chester being the principal ports with which they traded. For full details regarding the character of the traffic and its influence on the destinies of the city the reader may consult Francisque Michel's *Histoire du Commerce et de la Navigation de Bordeaux*, 1867. In 1548 the inhabitants resisted the imposition of the salt-tax by force of arms, a pardonable rebellion for which they were punished by Montmorency with merciless severity. At a later period they held out for the Frondeurs against the royal army under Louis XIV. and Richelieu, with an obstinacy that brought the monarch and his minister to a humbler mood. During the Reign of Terror the city suffered almost as severely as Lyons and Marseilles, and its commerce was greatly reduced under Napoleon I. In 1814 it declared for the House of Bourbon; and Louis XVIII. afterwards gave the title of duke of Bordeaux to his grandnephew, better known as the Count de

Chambord. In 1870 the French Government was transferred to Bordeaux from Tours on the approach of the Germans to the latter city. Population in 1872, 190,682.

Dupré de Saint Maur, *Hist. Curieuse de Bordeaux*, 1760; Devienne, *Hist. de la ville de Bordeaux*, 1771 and 1862; Bernadau, *Hist. de Bordeaux*, 1838–40; O'Reilly, *Hist. complète de Bordeaux*, 1853–60.

BOREAS, in Greek Mythology, was a personification of the north wind, and to be like it he was represented as rough, powerful, and accustomed to gain his ends by irresistible force. A favourite instance of this was the story of his carrying off the beautiful Oreithyia, a daughter of Erechtheus, king of Athens, when he found her gathering flowers by the banks of the Ilissus, or at the sources of the Cephisus,—others said the Areopagus, and others, again, the Citadel. He had sought before to woo her in vain, and now carried her to Mount Hæmus in Thrace, where they lived as king and queen of the winds, and had two sons, Zetes and Calaïs, and two daughters, Cleopatra and Chione. For the loss of Oreithyia the Athenians in after times counted on Boreas's friendliness, and were assured of it when he sent storms which wrecked the Persian fleet at Athos and at Sepias. For this they erected to him a sanctuary, or, as others said, an altar near the Ilissus, and held a festival in his honour. Thurii also, which was a colony of Athens, offered a sacrifice to him every year, because he had destroyed the hostile fleet of Dionysius the elder. Boreas was described as a son of Astræus and Aurora. In works of art he was represented as bearded, powerful, draped against cold, and winged. On the Tower of the Winds at Athens he is figured holding a shell, such as is blown by Tritons. Boreas carrying off Oreithyia is the subject of a beautiful bronze relief in the British Museum, found in the island of Calymna. The same subject occurs frequently on the painted Greek vases.

BORELLI, GIOVANNI ALFONSO, the head of what has been called the iatro-mathematical sect, or that which, misled by the great progress which the application of mathematics had produced in the physical sciences, attempted to secure the same advantage for medicine, by subjecting to calculation the phenomena of the living economy. He was born at Naples, January 28, 1608, taught mathematics for some time at Pisa, and seems afterwards to have held the professorship of medicine at Florence. He was greatly favoured by the princes of the house of Medici; but having been engaged in the revolt of Messina, he was obliged to retire to Rome, where he spent the remainder of his life under the protection of Christina, queen of Sweden, who honoured him with her friendship, and by her liberality softened the rigour of his fortune. He died of pleurisy on the 31st December 1679. Borelli, more judicious than Bellini, restricted the application of his system chiefly to muscular motions, or to those phenomena of the animal economy which are in certain points subject to the laws of mechanics, and was led to the discovery of some principles new in themselves, and directly opposed to the received beliefs of his time. His followers, less cautious, wishing to generalize the application he had made, by hypotheses, to which the return to a sound medical philosophy has done justice, greatly retarded the restoration of the science.

The works of Borelli are,—1. *Della Causa delle Febri maligni*, Pisa, 1658, 4to; 2. *De Renum usu Judicium*, Strasburg, 1664, 8vo; 3. *Euclides Restitutus*, 1628, 4to; 4. *Apollonii Pergæi Conicorum libri* v. vi. *et* vii., Florence, 1661; 5. *Theoriæ Medicæorum Planetarum ex Causis Physicis deductæ*, Florence, 1666, 4to; 6. *Tractatus de Vi Percussionis*, Bologna, 1667, 4to; 7. *Historia et Meteorologia incendii Æthnei*, Reggio, 1669, 4to; 8. *De Motionibus naturalibus a gravitate pendentibus*, Bologna, 1670, 4to; and 9. *De Motu Animalium, opus posthumum*, Rome, 1680, 1681, 4to.

BORGA, or BORGO, a seaport town of the Russian Grand Duchy of Finland, situated in the province of Nyland, at the entrance of the River Borga into the Gulf of Finland, about 25 miles N.W. of Helsingfors, in 60° 22′ N. lat. and 25° 45′ E. long. It was at one time a wealthy and handsome city, but has greatly decayed. It is still the seat of a Lutheran bishopric which extends over a large part of Finland; and it possesses a beautiful cathedral, a gymnasium (where the well-known Swedish poet Runeberg lectured for many years), and a theatre. The weaving of sail-cloth and the manufacture of tobacco are the principal industries, and the chief articles of trade are wood, butter, and meal. In 1873 the value of the imports, mainly from Germany, England, and Russia, was upwards of £141,000, while that of the exports was rather under £50,000. Borga was the seat of the Finnish diet in 1809. Population, which is mostly Swedish, in 1867, 3420.

BORGERHOUT, a flourishing township of Belgium, in the arrondissement of Antwerp, and on the road from that city to Turnhout. It has bleachfields, dye-works, woollen factories, and corn-mills. Population, 10,787.

BORGHESE, a noble Sienese family, one of whom, on being elected pope in 1605, assumed the name of Paul V., after which the family became among the most powerful of the Roman nobility by their union with the Aldobrandini. Camillo Filippo Ludovico, Prince Borghese (born 1775), married in 1803 Pauline, sister of the Emperor Napoleon, and widow of General Leclerc. In 1806 he was made duke of Guastalla, and for some years acted as governor of the Piedmontese and Genoese provinces. After the fall of Napoleon he fixed his residence at Florence, where he died in 1832. The Borghese palace at Rome is one of the most magnificent buildings in the city, and contains a splendid gallery of pictures.

BORGIA, CÆSAR and LUCRETIA. The history of Cæsar and Lucretia Borgia up to the death of their father has been related under ALEXANDER VI. (vol. i. p. 487). Alexander's sudden decease at an unfavourable conjuncture proved the ruin of Cæsar, who, as he subsequently told Machiavelli, had provided for every contingency except that of his father and himself being disabled at the same time. Though suffering from a dangerous illness, popularly believed to be the effect of poison, he possessed himself of his father's treasures, and exerted sufficient influence in the conclave to procure the election of a friendly pope. The pontificate of Pius III., however, only endured for a few weeks, and his successor, Julius II., the hereditary enemy of the Borgias, threw Cæsar into the prison of St Angelo, where he was detained until he had consented to deliver up all his fortresses. He was then sent to Naples, where the Spanish viceroy, Gonsalvo de Cordova, in violation of his pledge, caused him to be arrested and sent to Spain. After two years' confinement in the castle of Medina del Campo, he escaped and took refuge with his brother-in-law, the king of Navarre, in whose service he was slain before Viana, March 12, 1507. Cæsar possessed considerable abilities, but these are in general much overrated by historians, especially by Lord Macaulay in his essay on Machiavelli. His extraordinary success was not so much owing to the superiority of his qualities as to his utter emancipation from every restraint of conscience and honour. As a ruler he was intelligent and sagacious; his subjects regretted him, and his mercenaries served him with remarkable fidelity. Lucretia Borgia's life, after her marriage to the duke of Ferrara's son, was prosperous and uneventful, or at most only troubled by the not very well attested homage of Cardinal Bembo. She obtained universal respect by her piety and prudence, and her patronage of men of letters, and died in 1520. In fact, although intelligent and highly educated she was essentially a common-place woman, incapable from every point of view of the atrocities imputed to her by libellers in her own

day, and by poets and romancers ever since. She has suffered vicariously for her father and brother. See especially her latest historian, Gregorovius (*Lucrezia Borgia*, 1874), whose volumes contain a mass of most interesting information, especially relating to Lucretia's early years, but whose vindication of his heroine might have been much more decided. The English biography by Gilbert is well intended, but devoid of literary or historical value. (R. G.)

BORGO SAN DONNINO, a walled town of Italy, in the province of Parma, and capital of a circondario, is situated on the Stirone, a sub-tributary of the Po, about 15 miles W. of Parma on the railway to Milan. Besides its cathedral, a building of the 13th century, in the Lombard style, adorned with rude sculptures, it possesses a castle and fort, a theological seminary, a college, a music school, and a remarkable institution for mendicants. The spinning of hemp and silk and the manufacture of glass are its principal industries. Borgo is identified with *Fidentia*, memorable in ancient history for the siege sustained by M. Lucullus, one of Sulla's generals, against the forces of Carbo. It is mentioned as a *municipium* by Pliny, but seems afterwards to have sunk to a mere village. In 304 it was the scene of the martyrdom of Saint Domninus, from whom it has derived the distinctive part of its modern name. During the Hohenstauffen dynasty it was an imperial possession, and in 1501 it became the seat of a bishop. Population, 10,855.

BORGOGNONE, AMBROGIO. See FOSSANO.

BORGU, or BARBA, a large district in the interior of Africa, bounded on the E. by the Niger, on the S. by Yoruba, on the W. by Dahomey, and on the N. by Gurma. It is about thirty days' journey in length and eleven in breadth. It has generally a level surface, though crossed by a considerable range of mountains. The soil is mostly fertile, and tolerably cultivated, producing in abundance corn, yams, plantains, and limes. The cattle are numerous and of excellent breed, and there is a copious supply of all the species of game that prevail in Africa. A considerable inland trade between Haussa and the coast passes through this territory. When Clapperton entered it from Eyeo, he was warned to be on his guard, as the people were the greatest robbers and plunderers in all Africa, but he found this bad report altogether unjust. The people were honest, cheerful, obliging, good-humoured, and communicative. The district of Borgu is divided into a number of states, of which the smaller, such as Boussa, Wawa, Kiama, and Lugu, are dependent on the Fellatah kingdom of Gondo, while Kiti is ruled by a powerful and independent chief, who is frequently spoken of as sultan of Borgu. Wawa and Kiama are important commercial cities. Boussa was the scene of the disastrous fate of Mungo Park in 1805.

BORING. The methods and apparatus of boring will be found noticed under the different industries in which it is employed. See ARTESIAN WELLS, BLASTING, COAL, GUNS, &c.

BORISSOGLIEBSK, a town of Russia, in the government of Tamboff, 11½ miles S.E. of that city, in 51° 22′ N. lat. and 41° 4′ E. long., on the left bank of the River Vorona. It was founded in 1646 to defend the southern frontiers from the incursions of the Crim Tatars, and in 1696 was surrounded by wooden fortifications by command of Peter I. The public buildings include four churches, a hospital, and two schools; the principal industries are the preparation of wool, the manufacture of cast-iron, soap-boiling, tallow-melting, and brick-making; and the trade, which is decidedly important, consists in grain, wool, cattle, and leather. There are two annual fairs, and markets twice a week. Population in 1867, 12,254.

BÖRKU, or BORGU, a country in the interior of Africa, situated between the 17th and 20th parallels of N. lat., and between 18° and 21° E. long., and forming part of the great Soudan region. It is bounded northwards by the Tibesti Mountains, and is in great measure occupied by lesser elevations belonging to the same system; to the south or rather south-west lies the Bodele basin, from which it is separated by a narrow stretch of higher ground. The climate is much better than that of the neighbouring countries to the south and east; but the eastern trade-winds blow persistently with great violence, being strongest from early morning till about three P.M. The light sand that covers a large part of the country is drifted by it into countless heaps, that change their shape and position from day to day. It is plain, from the fish-skeletons still strewing the ground, that a considerable portion of the south of Borku has at no very distant day been like Bodele and other districts under water. At present the irrigated and fertile portions consist mainly of a number of valleys separated from each other by low and irregular limestone rocks. Of these the most important are Jin, Nguro, Elleboë, and Kirdi in the south, and Bodo, Tiggi, and Jarda in the north. They furnish excellent dates, of about twelve different sorts. The northern valleys and Jin are inhabited by a settled population of about 5000 people, known as the Donosa or Dosa; the others are mainly visited by nomadic tribes. The Uelad Sliman, a powerful Arab tribe, claim the lordship of the land, but have to share their authority with another tribe known as Mgharba which immigrated from Barca about 1860. They do not inhabit the country of Borku, but give proof of their claim to possession by plundering the valleys every three or four years. In the end of 1851 Dr Barth and Dr Oberweg joined an army despatched by the sultan of Bornu for the conquest of the region east of Lake Chad; but the army was defeated and put to flight, and the travellers were disappointed in their expectation of reaching Borku. Dr Nachtigal spent some time in the country in the year 1871, and gives an account of his sojourn in the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin*, 1873.

BORLASE, WILLIAM, a learned antiquary and naturalist, was born at Pendeen in Cornwall, of an ancient family, February 2, 1696. He was educated at Exeter College, Oxford, where he took his degree as master of arts. In 1720 he was ordained as priest; he was instituted in 1722 to the rectory of Ludgvan, and in 1732 was presented to the vicarage of St Just, his native parish. In the parish of Ludgvan are rich copper works, abounding with mineral and metallic fossils, of which he made a collection, and thus was led to study somewhat minutely the natural history of the county. In 1750 he was admitted a fellow of the Royal Society; and in 1753 he published, in folio, at Oxford, his *Antiquities of Cornwall*, a second edition of which was published at London, 1769, with the title of *Antiquities, Historical and Monumental, of the County of Cornwall; consisting of several Essays on the Ancient Inhabitants, Druid Superstition, Customs, and Remains of the most remote Antiquity in Britain and the British Isles, exemplified and proved by Monuments now extant in Cornwall and the Scilly Islands; with a Vocabulary of the Cornu-British Language.* His next publication was *Observations on the Ancient and Present State of the Islands of Scilly, and their importance to the trade of Great Britain*, Oxford, 1756, 4to, which had previously been printed in the *Phil. Trans.* In 1758 appeared his *Natural History of Cornwall*, Oxford, folio. He presented to the Ashmolean Museum a variety of fossils and antiquities, which he had described in his works, and for his benefactions received the thanks of the university, and the degree of LL.D. He died August 31, 1772. Borlase was well acquainted with

most of the leading literary men of the time, more particularly with Pope, with whom he kept up a long correspondence, and for whose grotto at Twickenham he furnished the greater proportion of the fossils and minerals. His letters to Pope, St Aubyn, and others, with answers, fill several volumes of MS. There are also MS. notes on Cornwall, and a complete unpublished treatise *Concerning the Creation and Deluge.* Some account of these MSS., with extracts from them, will be found in the *Quarterly Review*, October, 1875. Borlase's memoirs of his own life were published in Nichol's *Literary Anecdotes*, vol. v.

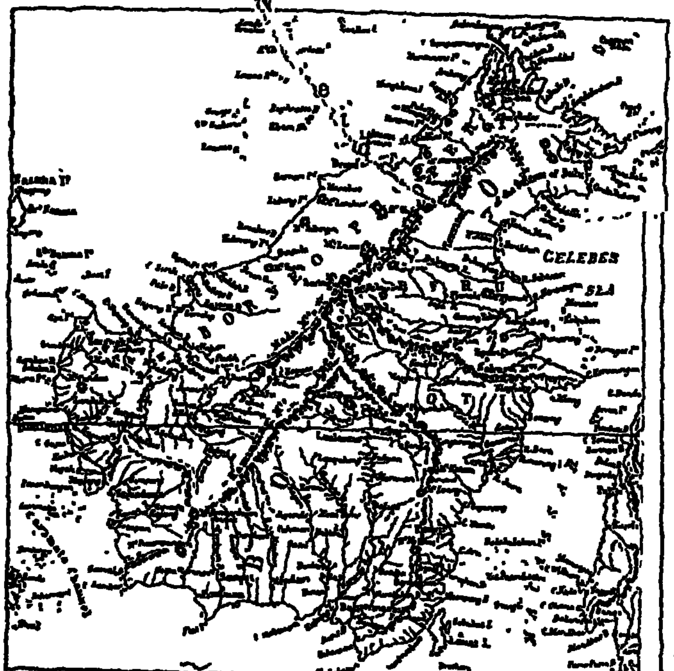
BORN, Ignatius, Baron von, an eminent mineralogist and metallurgist, was born of a noble family, at Karlsburg in Transylvania, in 1742 He was educated in a Jesuit college at Vienna, and entered that order, which, however, after sixteen months, he quitted. After studying law at Prague he travelled into Germany, Holland, and France. On his return to Prague he engaged in the study of mineralogy. Austria produces various metals in considerable abundance, and the administration of the revenue arising to Government from this source is conducted by local boards, under the control of the chamber of mines at Vienna. This administration offers a field of some preferment; and Von Born was received into the department of the mines and mint at Prague in 1770. About this time he met with an accident which nearly proved fatal, in the course of a journey through Transylvania. Having entered a mine at Felso-Banya, whilst the air was charged with arsenical vapour, he was stupified for fifteen hours, and long afterwards suffered from a cough and general pain. Some time after this accident he was affected with violent colics, and in the latter part of his life was deprived of the use of both legs. These calamities, however, did not repress the activity of his mind. He had to give up his assessorship of the mining council, but continued to produce works on mineralogy which won him a European reputation. He met with much opposition in attempting to introduce amalgamation in Hungary, in place of smelting and cupellation, for extracting silver from the ores. His opponents endeavoured to prove his process inferior to that already in use; and, after it had been tried successfully, pronounced it to be merely the old Spanish process of amalgamation. The emperor, however, ordered that his method should be employed in mines belonging to Government, and that he should receive a third part of the savings arising from the improvement during the first ten years, and 4 per cent. of this third part for the next twenty years. In 1766 he was appointed by Maria Theresa to arrange the imperial museum at Vienna, where he was made councillor of state, and continued to reside until his death. Von Born attempted satire with no great success. The *Staats Perucke*, a tale published without his knowledge in 1772, and an attack on Father Hell, the Jesuit, and king's astronomer at Vienna, are two of his satirical works. Part of a satire, entitled *Monachologia*, in which the monks are described in the technical language of natural history, is also ascribed to him. Von Born was well acquainted with Latin and the principal modern languages of Europe, and with many branches of science not immediately connected with metallurgy and mineralogy. He took an active part in the political changes in Hungary. After the death of Joseph, the diet of the states of Hungary rescinded many innovations of that scheming ruler, and conferred the rights of denizen on several persons who had been favourable to the cause of the Hungarians, and, amongst others, on Von Born. At the time of his death in 1791, he was employed in writing a work entitled *Fasti Leopoldini*, probably relating to the prudent conduct of Leopold II., the successor of Joseph, towards the Hungarians.

BÖRNE, Ludwig, German political writer and satirist, of Jewish family, was born 18th May 1786, at Frankfurt-on-the-Main, where his father, Jakob Baruch, carried on the business of a banker. He studied first at Berlin, where he became acquainted with Schleiermacher and the famous Henrietta Herz, and afterwards at Halle, intending to enter the medical profession. His inclinations for pure literature proved too powerful to allow him to carry out this design, and in 1806 he removed to Heidelberg in order to study financial and political economy. Two years later he took his degree at Giessen, and in 1811 he received an appointment in the bureau of police in his native town. The reconstitution of Frankfurt as a free city after the fall of Napoleon's power in Germany soon deprived him of a situation which was but little suited to his tastes or abilities. He then devoted himself to literature, and for a time edited a newspaper entitled *Staats-Ristretto*, which was quickly suppressed by the Government on account of its liberal tone and the boldness of its criticisms. The same fate attended his next venture, *Die Zeitschwingen*, which appeared for only four months. In 1817 he renounced his Jewish faith and took the name of Börne, by which he is always known. From 1818 to 1821 he edited *Die Wage*, a paper particularly distinguished by its lively political articles, and by its powerful but sarcastic theatrical criticisms. For some years after the suppression of his paper, Börne resided principally in Paris, Hamburg, and Frankfurt. After the July revolution (1830) he hurried to Paris, expecting to find the newly constituted state of society somewhat in accordance with his own philosophic views; but in this hope he was completely disappointed, and the bitterness of his anger lent additional force to the satirical letters he began to publish in his last literary venture, *La Balance.* While advocating his favourite scheme of a closer union between France and Germany, he assailed with unsparing sarcasm and polished wit the German dynasties, whom he looked upon as the great opponents of liberalism. He died at Paris in 1837. Börne's works are remarkable for brilliancy of style and for a thoroughly French vein of satire. His most elevated piece of criticism is the *Denkrede auf Jean Paul*, in which he shows himself fully able to appreciate the great German humourist. The *Menzel der Franzosenfresser* may be taken as a specimen of his unrivalled powers of sarcasm. There have been several complete editions of his writings, the latest being that of 1862, 12 vols., Leipsic; his life has been written by Gutzkow, 1840.

BORNEO, one of the largest islands of the world, is situated about the middle of the East Indian Archipelago, and lies immediately under the equator, between 7° N. and 4° 20' S. lat., and between 109° and 118° E. long. It forms a kind of irregular hexagon, and its area is estimated by Engelhardt at 289,000 Eng. square miles (more than double the area of the United Kingdom). Its coast-line is much less broken than that of most of the neighbouring islands; and though there are some extensive bays, such as Maludu in the north and Sarawak in the west, none of them are so deep as greatly to interfere with the regularity of its contour. A large proportion of the seaboard is of alluvial formation; and in various districts the deposition of new land is very perceptibly going on. The whole of the ground, for example, to the west of the Kandang Mountains in the kingdom of Landak has been gained from the sea during the last four centuries, and it is evident that many smaller islands which fringed the coast in former times have been incorporated with the mainland. This process of extension goes on all the more rapidly, because the neighbouring sea is very shallow, except on the eastern side.

Of the interior of the island a considerable part has been only partially explored, so that the physical features can

hardly be given with sufficient precision and detail. The general character of the country is mountainous, though none of the ranges and few of the individual peaks attain to any greatest elevation. The centre of the island seems to be occupied by a kind of table-land, with which the principal chains connect themselves more or less directly. Of these the most extensive may be traced from Cape Datu, on the west coast, in 2° 5′ 24″ N. lat., northwards through the length of the island, which it divides as water-



Sketch-Map of Borneo.

shed into two portions, a north-western of comparatively narrow dimensions, and a south-eastern comprising the rest of the island. The different parts of the chain are known by various local names, as the Krimbang or Bayang-Mint, the Batang-Lupar, the Madi, and the Anga-Anga Mountains. In the north-west corner of the island it attains its highest elevation in Kini-balu, or St Pietersberg, which is generally supposed to be the highest peak in the whole island. According to the trigonometrical measurement of Capt. Belcher the summit is 13,698 feet above the level of the sea, but this was in 1851 reduced to 9500 by Messrs Low and St John, who were the first to ascend the mountain. A second great chain, known as the Kaminting Mountains, stretches south-west from the Anga-Anga, and fills the south-west corner of the island with numerous offshoots and underfalls; and a third starting from the same quarter strikes first south-east and then south along the southern part of the eastern coast, and is known as the Meratu Mountains. A fourth chain, of which the most important part bears the name of Sakuru, runs almost due east to Cape Kamiungun.

Unlike the most of the larger islands of the archipelago, and in remarkable contrast with Java, Borneo seems to possess no active volcanoes. Many of the peaks, however, bear distinct evidence of former activity in regular craters, now in some cases forming lakes of salt water. The prevailing rocks are limestone, slate, sandstones, conglomerates, and on the mountain tops syenitic granite. The limestone hills are remarkable for the number of their caves, many of which, such as those of Rumbary, are a source of wealth to the natives, as they afford shelter to swallows that build edible nests.

Rivers. The island, which is abundantly supplied with rivers and streams, may be hydrographically divided into five principal versants. Of these the shortest lies along the north-western slope of the Krimbang and Kini-balu range, and discharges its waters into the Chinese Sea. The most important of its rivers are the Sarawak, the Batang-Lupar, the Seribas, the Rejang (which is navigable for 140 miles), the Baram (about half a mile wide at its mouth), the Limbang or Bruni River, the Tewaran, the Bintulu, and the Tampasuk, the last two having their sources in Mount Kini-balu itself. In the south-western versant the largest river is the Kapuas, which, rising towards the centre of the island, in about 114° E. long., falls, after a long and winding course, into the sea between Mempawa and Sukkadana. It has eight navigable mouths, and at Sintang, where it receives the Melawi, its principal tributary, it has a breadth of 1072 feet and a varying depth of 6 to 11 fathoms. The Banjermassin or Barito, which is the master stream of the southern versant, rises in the Kuti-Lama Lake, and reaches the Sea of Java in 114° 30′ E. long. Its upper channel is greatly interrupted by rocks and waterfalls, but the lower part of its course is wide and navigable, and traverses a rich alluvial district. Cross branches unite it with two rivers of considerable size towards the west, the Little Dayak or Murung and the Great Dayak or Kahayan, and still further west are the independent rivers Mendawi, Sampit, Pembuang or Surian, and Kota-Waringin. Passing over the south-east corner of the island, which is watered by a large number of short mountain streams, we reach the one great river of the eastern versant, the Kuti (Coti) or Mahakkan, which, rising in Mount Lassan-Tula, flows east, with a rapid and sinuous course, and falls by numerous mouths into the Strait of Macassar. Most of the rivers of the northern versant are comparatively small, as the island narrows into a kind of promontory. Besides the Sebuku, which rises in Mount Pentyieangan and falls into the sea at Temelingan, the Berou, the Gunong-Tebur, and the Bulungan are all worthy of mention.

Lakes. Among the lakes of Borneo that of Kini-balu, near the mountain of the same name, is regarded as the largest, but many others are of considerable size. The Danau Sriang, for example, on the Kapuas River, is, according to Dr E. van Martens, larger than the Lake of Constance. In the valley of the Banjermassin are the Babi and the Pamingir (or Telaga) lakes, the latter of which supplies nearly all the inhabitants of the kingdom with fish; and in the district of Sintang there is an extensive sheet of water, on the Kapuas-Tawang, which was discovered in 1825, and is known by the various names of the Luar, Sumbah, Malayu, or van Capellan Lake.

In spite of the equatorial position of the island its climate is nowhere oppressive, and in many places might almost be called temperate. At Pontianak, for example, which is almost under the equator, the mean reading of the thermometer is 82°, while it varies from 76° to 79° at sunrise, and hardly ever, even at noon, exceeds 92°. The difference between the rainy season and the dry is not rigidly marked; the atmosphere is moist all the year round, and while, on the one hand, there is hardly a day of continuous downpour, there is hardly, on the other hand, a day without a shower. During the rainy season, which extends from November to May inclusive, the torrents, while they last, are tremendous, and the wind is frequently violent. Over such an extensive area there is, of course, great variety in the climatic character of different districts, especially when viewed in relation to health. Some places, as Bidi, for example, are notoriously unhealthy; but from the statistics of the Dutch Government it appears that the European has in general no more to fear in Borneo than in the island of Java. Among the native races the prevailing diseases are principally those that arise from bad food or want of cleanliness. Scrofula is common throughout the

country, and elephantiasis is frequently met with on the coast. Small-pox, dysentery, and fevers are the usual epidemics; and ophthalmia sometimes attacks whole tribes. About a sixth of the native population in some quarters suffer from a kind of ringworm, called kurab, which is identified with *herpes farinosus.* Consumption is not uncommon.

The mineral wealth of Borneo is great and varied, including diamonds, gold, platina, quicksilver, cinnabar, copper, iron, tin, antimony, petroleum, sulphur, rock-salt, marble, and coal. Landak and Pontianak are the best diamond districts, and Sambas, Landak, Montrado, and Borneo Proper furnish the greatest quantity of gold. The annual amount of gold collected in the island cannot be ascertained; but the amount exported from Bruni in 1870 was 5789 dollars. Coal of excellent quality is found in the valleys of the Banjermassin, the Kuti, the Gunong-Tebur, and the Melawi, as well as in Sarawak, and in the island of Labuan. The Kuti deposit was discovered in 1845 or 1846 above Samarinda, and has since been struck in a number of places along the main river and several of the tributaries. A mine was opened at Pelarang, but does not seem to be at present worked. Another, however, at Pengaron, on the Riam Kiva, yields annually about 9000 or 10,000 tons. The coal-fields in Borneo Proper were conceded to Sir James Brooke in 1846, and since 1868 have been in the hands of the Oriental Coal Company, which has as yet taken no advantage of its rights. Antimony was discovered to be a Bornean product by Mr J. Craufurd, the well-known geographer, who, in 1825, learned that a quantity had been brought to Singapore by a native trader as ballast. The supply is practically unlimited, and the chief mine is at Bidi in Sarawak.

The fauna of Borneo comprises a large variety of species, many of which are numerically of great importance. Among the Quadrumana, which are very well represented, the most remarkable is the orang-outan (or *mias*, as it is called by the natives), an animal only to be found elsewhere in the Island of Sumatra. It frequents the low-lying districts, especially in the neighbourhood of the Dyak plantations. The wawah, a kind of gibbon, several *Semnopitheci* (as the longnosed ape and the golden-black or chrysomelas), and the large-eyed *Stenops tardigradus* are also worthy of mention. The larger beasts of prey seem to be altogether wanting, so that little check is put on the natural fecundity of the graminivorous species. A small panther and the *Felis macrocelis* are the largest animals of the cat-kind known; for though the tiger has sometimes been reported to occur in the mountains, its presence has never been verified. The Malay or honey bear is very common. The rhinoceros is found on the north-west coast, and the elephant, introduced by the Chinese or Portuguese, in the neighbourhood of Cape Unsang. Wild oxen of the Sunda race are not uncommon; and the whole island swarms with droves of wild pigs, which are distinguished by a curious protuberance of hair on each side of the head. These furnish food not only to the Dyaks, who are very fond of the flesh, but also to the crocodiles that abound in the principal rivers. Three or four species of deer are enumerated, one of which, the pelandok of the Malays, is remarkable for its smallness and beauty. Squirrels, porcupines, civet-cats, rats, bats, and lizards are well represented, and snakes of various kinds, from the boa constrictor downwards, are abundant, while the marshy districts swarm with frogs and leeches. The latter attach themselves in a most troublesome manner to the passing traveller. A remarkable flying-frog was discovered by Mr Wallace. Birds are comparatively rare in many quarters; the most important being eagles, vultures, falcons, owls, horn-bills, cranes, pheasants,—notably the Argus-pheasant,—partridges, ravens, crows, parrots, woodpeckers, doves, and swallows. The *Cypselus esculentus*, or edible-nest swallow, is very common. Mosquitoes and sandflies are the chief insect pests, and in some districts are very troublesome. There is also a kind of ant called the *sumpit-api* or fire-ant, the sting of which is very painful. The lepidopterous insects are remarkable for their number, variety, beauty, and size. In one favourable situation Mr Wallace caught 120 different species of moths in one night. The Coleoptera are no less numerously represented, as, indeed, might be expected in so richly-wooded a region. The lakes and rivers, as well as the surrounding sea, abound with fish. Dr Bleeker in his "Bijdragen tot de Kennis der Ichthyologische Fauna van Borneo," in the *Natuurkundig Tijdschrift van Nederl. Ind.*, describes 176 species which he obtained during his residence in the island.

The domestic animals of Borneo are few both in number of species and for the most part in number of individuals. The character of the country has prevented the development of pastoral modes of life. In some districts, as in the neighbourhood of Ambong, there are bullocks of the Brahmin breed, about thirteen hands high; the buffalo is sometimes employed in agriculture; and sheep and goats occur. The cat and dog are both domesticated. A few horses, introduced by Europeans, and only possessed by the wealthier classes, are found in Banjermassin and Sarawak.

The flora of Borneo is very rich, the whole surface of Pl
the island being clothed in luxuriant vegetation. The king of the forest is the *tappan*, which, rising to a great height with a single branchless stem, is crowned with a splendid dome of foliage. From the wood of this tree the chiefs construct their official seats. The iron-wood, so remarkable for the durability of its timber, is abundant; it is used by the natives for the pillars of their houses, and forms an article of export to China. It is almost rivalled by the *kayu temesu* in hardness. In all about sixty kinds of timber are furnished in more or less profusion. Palm-trees are abundant in great variety, including the *nipa*, cabbage, fan, cocoa-nut, and sago palms; the two last afford large supplies of food to the natives. Gutta-percha, camphor, cinnamon, cloves, nutmegs, gambir, and betel-nuts are all produced in the island; most of the tropical fruits flourish, such as the mangosteen, the lansat, rambutan, jack, jambon, and blimbang; nor must the wonderful durian be forgotten, of which Mr Wallace enthusiastically declares that it is worth a voyage from Europe to taste it. It is a large fruit with an exceedingly strong spiked outer covering, and not unfrequently inflicts severe wounds by falling on the passers by. Yams, potatoes (an indigenous sort), melons, pumpkins, cucumbers, pine-apples, and bananas, sugar, pepper, cotton, and tobacco are cultivated, though not as yet on a very extensive scale. In the south-eastern division of the Dutch territory the export of cotton was in 1854 1795 picols. The product of the wild plant is very good, and is exported from Borneo Proper. Among the more beautiful of the flowering plants are rhododendrons, orchids, and pitcher-plants,—the last reaching a most extraordinary development, especially in the northern districts about Kinibalu. Epiphytous plants are very common, many that are usually independent assuming here the parasitic character. The *Vanda Lowii*, for example, "grows on the lower branches of trees, and its strange pendent flower-stalks often hang down so as almost to reach the ground." Ferns are abundant, but are not so varied as in Java; Mr Wallace collected fifty species.

The population of Borneo consists of a considerable Inhal
variety of races, of very different origin, and of different tants
degrees of civilization. The most important numerically are the Dyaks, the Malays, the Chinese, and the Bugineso:

and, from their political influence, the Arabs and the Dutch.

Dyaks. The Dyaks, Dayaks, or Dayakkers are generally regarded as the most aboriginal. For themselves they have no general designation; but, broken as they are into numerous tribes, they are distinguished by separate tribal names, many of which seem to be merely the names of the rivers on which their settlements are situated. Though regarded by the Malays as aliens, and looked down upon as almost beneath humanity, they belong to the same race. Separation, however, must have taken place at a very early date. Kessel, who has attempted to form a classification of the Dyaks according to their ethnographical affinity, divides them into five principal branches. The first of these, which he calls the north-western, includes the natives of Sadong, Sarawak, Sambas, Landak, Tayan, Melionow, and Sangow. They all speak the same language, and are remarkable for their dependence on the Malay princes. The second branch, which is called emphatically the Malayan from its greater retention of Malay characteristics, occupies the north coast in Banting, Batang-Lupar, Rejang, and part of the valley of the Kapuas. To the third or Parian branch belong the Dyaks of the rivers Kuti and Passir, who are said to speak a language like that of Macassar. The fourth consists of the Beyadjoes, who are settled in the valley of the Banjermassin; and the fifth and lowest comprises the Manketans and Punans, who are still nomadic and ignorant of agriculture. In stature the Dyak is rather above the Malay, while still considerably shorter than the average European. He is rather slightly built, but is active and capable of enduring great fatigue. His features are distinctly marked and often well-formed, though the cheekbones are higher and the nose more *retroussé* than agrees with the European standard. The forehead is generally high, and the eyes are dark; the hair is black, and the colour of the skin a pure reddish brown, that frequently, in the female, approaches to a Chinese complexion. In general neither beard nor whiskers are present, but this does not hold of all the tribes. In dress there is considerable variety, great alterations having resulted from foreign influence. The original and still prevailing style is very simple, consisting of a mere *chawat* or waistcloth, generally of blue cotton, for the men, and a tight-fitting petticoat for the women, who acquire a peculiar mincing gait from its interference with their walking. The favourite ornaments of both sexes are brass rings for the legs and arms, hoops of rattan decorated in various ways, necklaces of white and black beads, and crescent-shaped ear-rings of a large size. Tattooing is commonly practised by most of the tribes. The men usually go bare-headed, or wear a bright-coloured kerchief. The custom of betel-chewing being almost universal, the betel-pouch worn at the side is a necessary part of the equipment. The weapons in use are a *klewary* or curved sword and a long spear. The bow is unknown, but its place among some tribes is partly supplied by the *sumpitan*, or blowpipe, in the boring of which they show great skill. When going to war the Dyak invests himself with a strong padded jacket, which proves no bad defence. Not only is it a custom with many tribes to preserve the skulls of their slaughtered enemies as trophies of their success in war; but, as the possession of a certain number of human heads is necessary before a man can be admitted to some of the most important of his social privileges, it is usual for the young men to go out on private head-hunting excursions. The custom, however, is dying out before the influence of civilization.

The Dyak is decidedly intelligent; his memory is tenacious, and his powers of observation good. Unacquainted in his natural state with both reading and writing, his aptitude for acquiring these arts is greatly praised by missionaries. In moral character he is far superior to the civilized Malay, being unsuspicious and hospitable, and honest and truthful in a striking degree. The various tribes differ greatly in religious ceremonies and beliefs, and it is hard to give a satisfactory idea of them. They have no temples, priests, or regular recurrence of worship; but the father of each family performs such rites as the exigencies of each day demand. A supreme god seems generally acknowledged, but subordinate deities are supposed to watch over special departments of the world and human affairs. Sacrifices both of animals and fruits—and in some cases even of human beings—are offered to appease or invoke the gods; divination of various kinds is resorted to for the purpose of deciding the course to be pursued in any emergency; and criminals are subjected to the ordeal by poison or otherwise. There is a very strong belief in the existence of evil spirits, and all kinds of calamities and diseases are ascribed to their malignity. Thus almost the whole medical system of the Dyaks consists in the application of appropriate charms or the offering of conciliatory sacrifices. Many of those natives who have had much intercourse with the Malays have adopted a kind of mongrel Mahometanism, with a mixture of Hindu elements. The transmigration of souls seems to be believed in by some tribes; and some have a system of successive heavens rising one above the other very much in the style of the Hindu cosmogony. In the treatment of their dead the same variety prevails as in other things—they are sometimes buried, sometimes burned, and sometimes elevated on lofty framework. The Dyaks have no exact calculation of the year, and simply name the months first month, second month, and so on. They calculate the time of day by the height of the sun, and if asked how far distant a place is can only reply by showing how high the sun would be when you reached it if you set out in the morning. In agriculture, navigation, and manufactures they have made some progress. In a few districts a slight sort of plough is used, but the usual instrument of tillage is a kind of cleaver. Two crops, one of rice and the other of maize or vegetables, are taken, and then the ground is allowed to fallow for eight or ten years. They spin and weave their own cotton, and dye the cloth with indigo of their own growing. Their iron and steel instruments are excellent, the latter far surpassing European wares in strength and fineness of edge. Their houses are neatly built of bamboos, and raised on piles a considerable height from the ground; but perhaps their most remarkable constructive effort is the erection of suspension bridges and paths over rivers and along the front of precipices, in which they display a boldness and ingenuity that surprise the European traveller.

The Dyaks speak a variety of dialects, most of which are still very slightly known. The tribes on the coast have adopted a great number of pure Malay words into common use, and it is often hard to ascertain their own proper synonyms. The American missionaries have investigated the dialects of the west coast (Landak, &c.), and their Rhenish brethren have devoted their attention to those of the south, into one of which (that of Pulu Petak) a complete translation of the Bible has been made. Mr Hardeland, the translator, has also published a Dyak-German dictionary. (See Vocabularies in St John's *Life in the Forests.*) On the authority of the sultan of Bruni, who in 1824 visited Singapore, Crawfurd asserts that of the forty wild tribes that inhabit Bruni, eight had completely, and five partially, adopted the Malay speech. The dialect of the Kayans seems to be one of the purest,—nine-tenths of its words having no cognates in the other languages of the archipelago.

For an account of the Malays the reader must be referred to a separate article, but the Chinese require more particular notice. They seem to have been the Chinese inhabitants.

first civilized people who had dealings with Borneo: their own annals speak of tribute paid to the empire by Pha-la on the north-east coast of the island as early as the 7th century, and later documents mention a Chinese colonization in the 15th. The traditions of the Malays and Dyaks support these statements,—the people of Bruni regarding themselves as partly of Chinese descent, and the annals of Sulu recording an extensive Chinese immigration about 1575. Be this as it may, the flourishing condition of Borneo in the 16th and 17th centuries was largely due to trade with China. The Chinese founded in the 18th century an important colony in Bruni; but their numbers were lessened by the bad treatment of the princes. The Malay chiefs of other districts invited them to come and develop the mineral wealth of the country, and before long they were to be found in considerable numbers in Sambas, Montrado, Pontianak, and elsewhere. They were at first forbidden to engage in commerce or agriculture, and prevented from wearing fire-arms or possessing gunpowder. About 1779 the Dutch acquired immediate authority over all strangers, and thus had the means of controlling the new colonists, who soon proved themselves rather troublesome. Their numbers continually increased, and they pushed inland to new mineral districts, forming friendships and contracting marriages with the Dyaks. For the better management of their affairs they entered into extensive associations, which gradually assumed more and more of a political character until they were almost regular confederacies. This rendered them at once more disposed and more able to assert their claims to independence; and it cost both the Dutch Government and the Rajah of Sarawak several severe contests to bring them to terms. They form at the same time one of the most valuable elements in Bornean civilization, and are an industrious, intelligent, and well-educated race. It would be hard to find a man among them who cannot read and write; and their first care in a new settlement is to found a school. The greater part of those on the west coast are emigrants, originally from the northern boundaries of Quang-tung and Quang-si. They are rough, stern, and quarrelsome. A more polished class come from the coast district of Amoy, and look down on their ruder fellow-countrymen, from whom they keep themselves markedly distinct. The former class are called Kehs by the Borneans, and the latter Ollohs.

ties pula- In regard to the number of the population of Borneo it is difficult to arrive at anything like a satisfactory estimate. The inland districts seem to be very thinly inhabited; and the Dyaks increase in numbers at a very slow rate, in spite of their being both a healthy and moral people. This is attributed by Mr Wallace mainly to infecundity on the part of the women brought on by the excessive labour to which they are subjected from early girlhood. The population of the Dutch territory was stated in 1871 at 335,677 natives and 131 Europeans in the western division, and at 847,846 natives and 320 Europeans in the south-eastern, making a total of 700,386; but the statements rest on little better than conjecture. If they approximate to the truth, the population of the whole island may be set down at between 1,000,000 and 2,000,000. Earlier estimates carried the total as high as 3,000,000.

torial ons. Borneo is politically divided into Borneo Proper or Bruni (inclusive of Sarawak), the territory of the sultan of Sulu, and the Dutch possessions and protectorate. Bruni is an ro er. independent country, governed by a sultan, who is nominally absolute; but the real power is distributed among the subordinate chiefs, who act each as much as possible as his own master. The inhabitants are all serfs of the sultan or the chiefs, who may dispose of their property, their wives, or their children in the most arbitrary manner. Mahometanism is the state religion. The capital, also called Bruni, is a large and flourishing city. The estimates of its population have all along greatly varied. Among the most recent is one which makes it 30,000 or 40,000, while the population of the whole kingdom is given at 225,000. A considerable traffic is carried on with Malacca, Singapore, China, Rio, Sambas, Pontianak, and other places in the Dutch possessions. There is an extensive fishing in the river, the produce of which furnishes the people with a large proportion of their food. The fishermen form a distinct caste, and the same is the case with the workers in brass, the blacksmiths, the goldsmiths, the matmakers, &c. The manufacture of goldlace and silk embroidery is carried to great perfection. For accounts of Sarawak and the Sulu territory the reader is referred to separate articles.

The Dutch territory forms two great divisions, the western and the south-eastern. The western, governed by a resident, is subdivided into two parts, Pontianak and Sambas, the former administered by the resident himself and the latter by an assistant-resident and the sultan of Sambas. Pontianak includes Landak, Tajan, Mampawa, Sintang, Selimbou, Upper-Kapuas, and Montrado, while to Sambas belong the districts of Pamangkut and Seminis. The south-eastern division is subdivided into an eastern and a southern part. Under the southern are Kota-Waringin, Pembuang, Sampitite, Great and Little Dyak, Bekompai, Duson, Banjermassin, and Tanah-Laut; and under the eastern are Tanah-Bumbu, Kusan, Passir, Kuti, Sambiliung, Gunong-Tebur, Bulungan (the three last being also known as Berou), and the Tidung lands. The east coast, from Sebamban in Tanah Bumbu to Kaniungan in 1° 3′ N. lat., belongs immediately to the Dutch Government. In the western division several important military roads have been constructed, and the resources of the country are being opened up. Dutch territory.

Borneo has never, as far as we have information, formed a political unity; and even its physical unity as an island is so little known or considered by its native inhabitants that it possesses in their languages no general designation. As a natural consequence Borneo has no proper history. The island was first discovered by European navigators in the beginning of the 16th century, according to one account by Lorenzo de Gomez, a Portuguese, in 1518, and according to another by Don Jorge de Menezes in 1526. Before long commercial relations were formed with the natives by the Portuguese traders, at first in the city of Bruni itself, and then in various other maritime states. In 1573 their Spanish rivals tried to open a connection with Bruni, but their attempts were without success till the sultan being dethroned appealed to them for assistance, and was restored in 1580. From that time they kept up intercourse with the country, but it was not unfrequently interrupted by war. In 1645 an expedition was sent to punish the inhabitants of the capital for their piratical excursions. The real influence exerted by the Portuguese and Spaniards on the condition of the country was very slight; and the only effort at proselytizing of which we have record came to an untimely end in the death of the Theatine monk, Antonio Ventimiglia, who had been its originator. Meanwhile the Dutch and English had been gaining a footing in the island. In 1604 Waerwijck began to trade on the west coast, and in 1608 Samuel Blommaert was appointed Dutch resident in Landak and Sukkedana. The English appeared for the first time about 1609, and by 1698 had an important settlement at Banjermassin, from which, however, they were expelled by the influence of the Dutch, who about 1733 obtained from the sultan a monopoly of the trade. The Dutch, in fact, became paramount all round the west and south coasts, and the king of Bantam ceded his rights History.

of suzerainty to the company. The attention of the English was meantime turned to the north of the island, which was subject to the sultan of Sulu, from whom, in 1756, Alexander Dalrymple obtained possession of the island of Balambangan, and all the north-eastern promontory. A military post was established, but in 1775 it was surprised and destroyed by the natives under the *dutus* or subordinate chiefs, who were dissatisfied with the cession of their territory. This disaster rendered a treaty, which had just been concluded (in 1774) with the sultan of Bruni, in great measure a dead letter, and before the end of the century English influence in Borneo was practically at an end. The Dutch, too, were overtaken, in spite of apparent success, with a succession of misfortunes, through their own mismanagement; and in 1809 their settlements were all abandoned by order of Marshal Daendels. The natives along the coast, assisted and stimulated by immigrants from the neighbouring islands to the north, gave themselves more and more to piracy, and rendered the trade of civilized nations almost an impossibility.

In 1811, however, an embassy was sent to the British Government in Java by the sultan of Banjermassin to crave their assistance, and in reply Alexander Hare was despatched as commissioner and resident. He not only formed an advantageous treaty with the sultan, but got for himself a grant of a district of country which he proceeded to colonize and cultivate. An expedition was also sent against Sambas, and a post established at Pontianak. On the restoration of the Dutch possessions in 1818 all these arrangements were cancelled, and a free field was left to the enterprise of the Dutch Government. A succession of active commissioners—Boekholtz, Tobias, Halewijn, &c.—soon laid the foundations of an extensive supremacy. About half of the kingdom of Banjermassin was surrendered by the sultan in 1823, and further concessions were granted by his son in 1825. Meanwhile, George Muller was exploring the east coast, and obtained from the sultan of Kuti an acknowledgment of the Dutch authority—a concession which seems to have been immediately regretted, as the enterprising traveller was shortly afterwards killed. The outbreak of a war in Java turned the attention of the Dutch in some measure from Borneo, and nothing was done by them to check the piracy which was growing more and more unendurable. On the rise of Singapore direct trade had been opened with Sarawak and Bruni, and it was a matter of moment to the English merchants that their traffic should be safe. In 1838 Sir James Brooke, an Englishman, whose attention had been turned to the state of affairs in the Eastern Archipelago, set out for Borneo, determined, if possible, to remedy the evil. By 1841 he had obtained from the sultan of Bruni the highest authority in Sarawak, and before many years were over he succeeded in restoring order and peace to the district, and, with the assistance of the English Government, in repressing piracy. (See BROOKE and SARAWAK.) In 1847 the sultan of Bruni agreed to make no cession of territory to any nation or individual without the consent of Her British Majesty. The Dutch hopes of gradually incorporating the whole island were thus frustrated, but this served only to increase their activity in other directions. In 1844 the sultan of Kuti had acknowledged their protectorate, and about the same time a treaty of similar character was formed with Passir. Since 1834, when Gunong-Tebur, Tanjong, and Bulungan are said to have made a nominal submission, the boundaries of their authority have undergone no change to the north; and in general their political power has been rather rising in level, so to speak, over the southern part of the island than seeking to spread over a wider area.

Of the works on Borneo, which are very numerous, the following may be named:— Blommaert's *Discours ende ghelegentheyt van het eylandt Borneo int Jaar 1609*; *Hachelyke reystogt van Jacob Janss. de Roy na Borneo en Atchin in het jaar 1691*; Beeckman, *Visit to Borneo*, 1718; Valentijn's description in his great work, 1726; *Berigt van een reiziger over Borneo Propre* in P. P. Roorda van Eysinga's *Verschill. reizen en lotgevallen*, vol. iv.; G. W. Earl, *Eastern Seas*, 1837; W. L. Ritter, *Indische Herinneringen*, &c., 1843; S. Muller, *Reizen in den Ind. Archip.*; Keppel, *Expedition of the Dido*, 1846; Mundy, *Narrative of events in Borneo and Celebes*, 1848; Belcher, *Voy. of the Samarang*, 1840; H. Low, *Sarawak*, 1848; F. S. Marryat, *Borneo, &c.*, 1848; Keppel, *Visit to Ind. Archipel. by the Mæander*, 1853; J. C. Temple, *Private Letters of Sir J. Brooke*, 1853; H. St John, *The Indian Archip.*, 1853; C. A. L. M. Schwaner, *Borneo, Beschr. van het stromgebied van den Barito, etc., in den jaaren 1843–47*, 1853–4; P. J. Veth, *Borneo's Westerafdeeling*, 1854, 1856 (a work which has been largely used in the preparation of the present article); E. Francis, *Herinneringen uit het leven van een Indisch. ambtenaar*, 1856; J. J. Rochussen, *Toelichting, etc. van eenige daden van mijn bestuur*, 1853; W. A. van Rees, *Montrado, &c.*, 1858; C. J. Temminck, *Coup d'œil sur les poss. Neerland. dans l'Inde Archipel.*, 1846–50; Ida Pfeiffer, *Zweite Weltreise*, 1856; MacDougall, *Letters from Sarawak, addressed to a Child*, 1854; Crawfurd, *Descriptive Dictionary*, art. *Borneo*; W. E. Kroesen and F. H. van Vlissingen, *Cultuur- en Industrie-ondernemingen van Borneo*, 1859; J. Hasselman and F. H. van Vlissingen, *Beschouwingen over de exploitatie van Borneo*, 1859; Tracy, *History of the American Board of Commissioners for Foreign Missions*, 1842; Spenser St John, *Life in the Forests of the Far East*, 1862; F. Boyle, *Adventures among the Dyaks of Borneo*, 1865; A. R. Wallace, *The Malay Archipel.*, 1869; P. J. Veth, *Woordenboek van Nederl. Indie*, 1869; (in this work the reader will find a long list of articles on Borneo that have appeared in Dutch and other periodicals); "Contribuzioni geografiche italiane a Borneo" in the *Cosmos* of Guido Cora, 1874. (H. A. W.)

BORNHOLM, an island in the Baltic, belonging to Denmark, in the "Stift" of Seeland, between 54° 59' and 55° 18' N. lat., and between 14° 42' and 15° 8' E. long. It is about 20 miles in length by 14 in breadth, with a generally mountainous surface and steep and rocky shores. Besides a good freestone, which is largely exported for building, it furnishes limestone, blue marble, coal, and clay. Oats, flax, and hemp are cultivated. The population amounts to about 33,000, and is chiefly employed in agriculture, fishing, brewing, distillation, and the manufacture of earthenware. Weaving and clock-making are also carried on to some extent. The capital is Rönne, and there are six other small towns on the island,—Svanike, Nexöe, Hasle, Allinge, and Sandvig,—the total town population amounting to 11,100. On the north-west coast are the ruins of the castle of Hammershuus, which was built in 1158, and long served as a state-prison; while another old castle, erected by Christian V. in 1684, and important as commanding the entrance to the Baltic, is situated on Christiansöe, one of a small group of islands about 11 miles to the north-east. The island of Bornholm has had a very eventful history. For a short time, in the 9th century, it formed a separate principality or kingdom, which was afterwards united to Denmark. In 1510 it was captured by the Hanseatic League, and in 1522 it became directly subject to the city of Lübeck. In 1645 the Swedes took it by storm, and their possession of it was confirmed by the peace of Roeskild in 1658; but the sympathies of the people were with Denmark, and a popular insurrection succeeded in expelling the Swedish forces.

BORNU, or BORNOU, a kingdom of Central Africa, situated to the south-west of Lake Chad, and separated from the Niger by the kingdom of Haussa. Its area is estimated at 51,250 square miles, and its population at 5,000,000. The country is for the most part a flat alluvial plain, subject in its north-eastern portions to inundation from the lake and its tributary rivers—the Shari and the Yo. The former of these, which is by far the larger, serves as a boundary towards Baghermi on the east; the latter, rising in Haussa, flows north-east through the whole country. The soil is in general fertile and well watered, yielding large crops even under very imperfect cultivation.

One of the finest districts in the country is that of Uje, which is inhabited by the Ghamergu tribe. The labour is chiefly performed by female slaves, who, besides their other labours are obliged to perform the perilous task of guarding the growing crops against animal depredators. The rice and wheat are excellent, but are grown in small quantity. The grain which forms the staple food of the people, is a species of millet called *gussub*, which they form, not into bread (an article here entirely unknown), but into a species of paste, which, by the addition of butter and honey, forms the highest boast of Bornu cookery. Cotton and indigo grow wild, and afford the materials for the cloths finely dyed with blue stripes, which form the staple fabric of the country. Onions and water-melons are almost the only vegetables, and besides tomatoes the only fruits are a few limes and figs. The prevailing bush is the *Asclepias gigantea*, and the woods consist largely of acacias and tamarinds. The caoutchouc tree is very common, but its juice has not as yet been utilized by the inhabitants. All the domestic animals are reared, and there are very numerous herds of oxen, possessed chiefly by the Shuwa tribe. Animal food is thus very cheap, and forms a large proportion of the ordinary diet.

Wild animals, in great numbers, find both food and cover in the extensive districts of wood and marsh. Lions, giraffes, elephants, hyenas, crocodiles, and hippopotami are common; and antelopes, gazelles, ostriches, and various other animals are pursued as game. The country abounds with bees; and the honey, though only partially collected, forms one of the chief Bornuese delicacies. The climate, especially from March to the end of June is oppressively hot, rising sometimes to 105° and 107°, and even during most of the night not falling much below 100°. In May the wet season commences, with violent storms of thunder and lightning. In the end of June the rivers and lakes begin to overflow, and for several months the rains, accompanied with sultry weather, are almost incessant. The inhabitants at this season are severely afflicted with fever and ague, which carry off great numbers. In October the rains abate; cool, fresh winds blow from the west and north-west; and for several months the climate is both healthful and agreeable.

The leading people of the country, called Bornuese or Kanuri, present a perfect specimen of the negro form and features; having large mouths, thick lips, and broad noses, but good teeth and high foreheads. The females add to their want of beauty by extensive tattooing; they also stain their faces with indigo, and dye their front teeth black and their canine teeth red. The law allows polygamy, but even the richest have seldom more than two or three wives. The marriage ceremonies last for a whole week, the first three days being spent in feasting on the favourite national dishes, and the others appropriated to certain symbolical rites. The favourite amusement is to watch the wrestling of slaves taken in war from the neighbouring nations. Another amusement is a rude game bearing some resemblance to chess, played with beans and holes in the sand. The Mahometan religion is universally professed in Bornu, and with bigotry and violence. The prevailing language of the people is known as the Kanuri. It has no affinity, according to Dr Barth, with the great Berber family. A grammar was published in 1854 by S. W. Koelle, as well as a volume of tales and fables, with a translation and vocabulary.

The pastoral districts of the country are occupied by the Shuwas, who are undoubtedly of Arabian race, and speak a well-preserved dialect of that language. Of the date of their immigration from the East we have no knowledge; but they were in the country as early as the middle of the 17th century. Their total number is from 200,000 to 250,000, and they are divided into numerous distinct clans. Their villages in general consist of rudely-constructed huts, of an exaggerated conical form. Another tribe, called the La Salas, inhabit a number of low fertile islands in Lake Chad, separated from the continent by channels which those who know the tracts can ford on horseback.

The military force of Bornu consists almost entirely in cavalry, amounting to about 30,000, who are mounted on heavy steeds, which, as well as their riders, are frequently cased in light iron mail. The Shuwas, however, are clad only in a light shirt, and mounted on small unseemly nags, and the Kanembu spearmen are almost naked, and fight with shield and spear. Camels and oxen are used for conveying the baggage. The sheikh of Bornu is surrounded by a mounted body-guard, who likewise compose his principal nobles and chiefs. It is indispensable to the chief of rank that he should possess a huge belly, and when high feeding cannot produce this, padding gives the appearance of it. Notwithstanding the heat of the climate, the body is enveloped in successive robes, the number indicating the rank of the wearer. The head likewise is enclosed in numerous turbans.

The towns are of considerable size. They are surrounded with walls 35 or 40 feet in height, and 20 feet in thickness, having at each of the four corners a triple gate, composed of strong planks of wood, with bars of iron. The abodes of the principal inhabitants form an enclosed square, in which are separate houses for each of the wives; the chief's palace consists of turrets connected together by terraces. These are well built of a reddish clay, highly polished, so as to resemble stucco; the interior roof, though composed only of branches, is tastefully constructed. Kuka (or Kukawa, as it is called from its consisting of two distinct parts) is situated near the western shore of the lake, and has a population of 60,000. Still more populous is Ngornu, Angornou, or Gornu (the town of the "Blessing"), which lies about 18 miles to the south-east. It carries on a large trade, and contains about 50,000 inhabitants. On the Waube or Yo are still to be seen extensive remains of Old Bornu or Birni and Gambarou or Ghambaru, which were destroyed by the Fulbe about 1809. Among the other towns of more or less importance are Alaw, where Edris Alawoma, the famous king of Bornu, is buried, Alamay, Allauna, or Kabshari, Borzani, Lamiso, Masheña, Uje Maidugari, Uje Maibani, Wushek, and Yo.

The history of Bornu goes back only to the 9th century of our era, and its early portions are very fragmentary and dubious. The first dynasty known is that of the Séfuwa or descendants of Sef, which came to the throne in the person of Dugu or Duku, and has its capital at Njimiye in Kanem. Mahometanism was adopted about 1086 by the ruling monarch, Dúnama Ben Humé, and has since continued the religion of the country. From 1194–1220 reigned Selma or Abd-el Jelil, under whom the power of the kingdom was greatly extended; and Dúnama, his successor, was also a powerful and warlike prince. In the following reigns the prosperity of the country began to diminish, and in 1386 the dynasty was expelled from Njimiye, and forced to seek refuge in the western part of its territory by the invasion of the Bulála. Mai Ali Ghajideni, who founded the city of Birni or Ghasrggomo, on the River Wau, rendered his country once more redoubtable and strong. His successor, Edris, completely vanquished the Bulála and subjugated Kanem; and under Mohomet, the next monarch, Bornu reached its highest pitch of greatness. A series of for the most part peaceful reigns succeeded till about the middle of the 18th century, when Ali Omarmi entered upon a violent struggle with the Tuaricks or Imoshagh. Under his son Ahmed (about 1808) the kingdom began to be harassed by the

Fulbe or Fellatah, who had already conquered the Haussa country. Expelled from his capital by the invaders, Ahmed was only restored by the assistance of the fakir Mahomet el-Amin el-Kanemi, a mere private individual, who, pretending to a celestial *mission*, hoisted the green flag of the prophet, and undertook the deliverance of his country. The Fellatahs appear to have been taken by surprise, and were in ten months driven completely out of Bornu. The conqueror, having the army wholly devoted to him, might probably have, with little difficulty, assumed the sovereign power. More moderate, and perhaps more prudent, he invested the nearest heir of the ancient kings with all the appearance and pomp of sovereignty,—only reserving for himself, under the title of sheikh, all its reality. The court of the king or sultan was established at New Bornu, or Birni, which was made the capital, the old city having been entirely destroyed during the Fellatah invasion; while the sheikh, in military state, took up his residence at the new city of Kuka. Fairly established he ruled the country with a rod of iron, and at the same time inspired his subjects with a superstitious notion of his sanctity His zeal was peculiarly directed against moral or religious offences. The most frivolous faults of females, as talking too loud, and walking in the street unveiled, rendered the offender liable to public indictment, while graver errors were visited with the most ignominious punishments, and often with death itself. Kanemi died in 1835, and was succeeded by his son, Sheikh Omar, who altogether abolished the nominal kingship of the Sefuwa. The intercourse of Europeans with Bornu has, during his reign, been for the most part satisfactory as well as frequent. The expectations entertained at various times of opening up a valuable commerce with the people have not been as yet realized, and it seems likely, from the latest reports, that before long the traveller in Central Africa will have little to hope or fear from the sheikh of Bornu. Dr Barth, who was at Kuka in 1851, foreboded this decay; and Dr Nachtigal, who in 1870 conveyed the friendly presents sent by King William of Prussia, in acknowledgment of the sheikh's kindness to so many German explorers, writes thus in December 1872 :—

"The rapid declension of Bornu is an undeniable and lamentable fact. It is taking place with increasing rapidity, and the boundless weakness of Sheikh Omar—otherwise so worthy and brave a man—must bear almost all the blame. His sons and ministers plunder the provinces in an almost unheard of manner; trade and intercourse are almost at a *standstill*; good faith and confidence exist no more. The indolence of the court avoids military expeditions, and anarchy and a lack of security on the routes are the consequences. As two years ago the prince of Zinder could kill the Munioma or prince of Munio, a faithful vassal of the sheikh, and escape unpunished, the people of Khudadza have now slain the prince of Gummel. The sheikh will probably take their presents as indemnification, as he pardoned the sultan of Zinder for the murder of the faithful Munioma for the sake of a few camel-loads. Most of the small princes of the western provinces of Bornu now pay an indeterminate tribute to the prince of Zinder, who on his part has no less ambition than to become master of Bornu. Thus the sheikh and the land grow poorer and poorer, and public morality sinks lower and lower."

See Denham and Clapperton s *Travels*, 1828; Barth's *Travels in Central Africa*, vol. ii., 1857; Rohlfs's *Land und Volk in Africa*, 1873; Petermann's *Mittheil.*, 1871, pp 67 and 327.

BOROUGH. Although the idea of self-government by a town is exemplified in the *coloniæ* and *municipia* of Rome, and in their *duumviri*, *decuriones*, and lesser senate, composed of the curial orders, which along with the *defensor civitatis* appear to have existed in vigour until the reign of Leo the Philosopher (*Const.*, 46, 47), yet as the local power was gradually subordinated to the imperial, and as both in France and Italy it seems almost universally to have disappeared when the territorial jurisdictions, as well as the feudal fiefs, became hereditary, it is impossible to trace an historical connection between these institutions and the modern borough. In Spain and Languedoc, perhaps, the forms of ancient independence may have been continuously preserved, but the system of government by *comes* and *scabini* (or assessors), which was pursued in both France and Italy by the successors of Charlemagne, was obviously opposed to the freedom of towns. It is during the 11th and 12th centuries that we begin to read in charters of the *citizens* of Narbonne, the *burgesses* of Carcassonne, the *consuls* of Beziers, the *magistrates* of Rouergues, the *capitols* of Toulouse. It is during the reigns of Louis the Fat, Louis the Lion, and Philip Augustus that charters of *commune* become frequent. These charters, which sometimes bear to be granted on account of the poverty of the towns folk, the enormities of the clergy, or the attacks of the local *Seigneurs*, were probably dictated by the pecuniary needs of the Crown; but they attest the growing power—the *de facto* rights of the industrial population. They distinguish between *Bourgeoisies* and *Communes* proper: the former obtained a confirmation of ancient customs, of exemption from feudal jurisdiction, of personal liberty, but they did not obtain an elective municipal government. In Italy the revival of civic autonomy was much more rapid. Although Frederic Barbarossa reserved to himself in the peace of Constance the right of nominating consuls in the Italian towns, Bishop Otho of Frisingen tells us that the imperial influence did not count for much; and in 1288, at least, we have in the Potestas (Podesta), the Concilium Generale, and Concilium Novem Dominorum of Siena, a type of the independent republican city.

The Saxon *byrig* or *burh* is properly the fortified house of the powerful man. Related forms are *burgus* (Latin of 4th century); *burg* (High German); *baurgs* (Gothic); *borg* (Gaelic); *πύργος* (Greek); *bor*, *borc*, and *bourg* (French); and *broch*, a pledge. The *burgensis*, or inhabitant of a walled town, was opposed to *villanus*, or inhabitant of the *villa*, or open town. The Gemot, or assembly of the original township, had the power of making *by*-laws (the Danish prefix means "town"), and of electing the *Gerefa* (Reeve), the *Bydel*, and the Tithing-man or constable, the first of whom represented the assembly in the courts of the hundred and the shire. The *Gemot* also saw to the collection of taxes imposed by the higher courts, the pursuit of criminals, and the search for stolen goods. In mercantile places, such as London and Bath, the chief officer was called Port-Gerefa from the gates in which the market was held.

The freeholder of this period had undoubtedly political as well as personal liberty. Generally speaking, however, although common property may have been held by a guild or corporation, and special privileges of trade or inheritance may have been enjoyed, there is before the Conquest little trace of municipal organization. The Lagemanni of Lincoln and the Justices of Chester were apparently among the most ancient resident magistrates, but the manner of their election is unknown. The Conquest divided the boroughs into those which formed part of the royal demesne and those which held of the barons and dignified churchmen,—the interest of the Crown and its grantees in the property and in the profits of fairs and markets, &c., being, at first absolute, but latterly converted into a *firma burgi* or perpetual rent from the whole borough in lieu of tribute from individual *burgesses*. The non-elective bailiff succeeded to the reeve, and proved a useful agent in carrying out the oppressive and arbitrary *tallagia*, which were often the price of new or confirmed privileges. The bailiwicks were sometimes farmed out, and this led to still more severe exaction. To the bailiff succeeded the mayor (major), who accounted to Exchequer for the annual rents of the borough. Grants of jurisdiction, of *socan* and *sacan*, of *outfangenthef* and *infangenthef*,

and grants of the right of appointing *præpositi* (provosts), *ballivi* (from Greek βάλλειν or Latin *bajulus*), and *justiciarii* increase in number towards the reign of John, and are probably included along with the various exemptions from tolls, &c., granted by Henry II. in the "liberties and free customs" guaranteed by the Great Charter. The terms alderman, capital citizen, capital burgess, and jurat were of fluctuating signification; but the last three were finally applied to members of the Common Council which gradually took the place of the assembly of incorporated burgesses. The rights of a free burgess might be acquired by birth, apprenticeship, marriage, or purchase; and as prior to Edward III.'s Laws of the Staple these rights included exclusive privileges of trade, they were properly connected with the payment of local taxation and the performance of local duties, from which non-freemen (strangers and temporary residents) were exempt. In many cases it is probable that the "civitas," or community of freemen, was identical with the *convivium conjuratum*, or Secular Frith Guild of traders and craftsmen, possessing portions of town land. Such voluntary associations for protection of trade, the administration of common property, or for religious and charitable purposes, were more highly developed in England than in any other part of Europe. The members of the leading industry naturally assumed the direction of municipal affairs, and when their guild was recognized by the Crown their bye-laws acquired a binding force. For instance, in deeds of the 12th century relating to the magistrates of Paris the terms *burgenses* and *mercatores per aquam* are used as synonymous. (Brentano on Gilds.) Such guilds gave compensation to brethren who had incurred losses by shipwreck or undeserved misfortune, and made gratuitous loans to poorer brethren for carrying on their trade. It was their special endeavour to obtain staple right, the right of coinage, immunity from tolls, &c. Gradually, however, the distinction arose between the merchants proper who formed the *gildæ mercatoriæ*, and the craftsmen, who had at first traded in the raw materials they worked with, but who were now oppressed and deprived of civic rights by their wealthier brethren. The man "with dirty hands" or "blue nails," the man "without hearth or honour, who lives by his labour," or "hawks his wares in the streets," was threatened with a serfdom like that which the barons and bishops had imposed. But at this juncture the great craft guilds arose to assert the rights of manufacture. In the time of Henry VI. their victory in England was complete, and the Crown, which had previously recognized the constitution and liberties of a town by confirming the guild, now used in its charters the words of express incorporation (*communitas perpetua et corporata*). A glance at the names and forms of the most modern municipality will show how closely trade organization and burghal government have been intertwined.

In Ireland the earliest traces of burghal life are connected with the maritime settlements on the southern and eastern coast. The invasion of Henry II. colonized these Ostman ports with Anglo-Norman communities, who brought with them, or afterwards obtained, municipal charters of a favourable kind. The English settlement obviously depended on the advantages which the burgesses possessed over the native population outside. Quite different from these were the new close boroughs which during the plantation of Ulster James I. introduced from England. The conquest was by this time completed, and by a rigorous enforcement of the Supremacy and Uniformity Acts the existing liberties of the older boroughs were almost entirely withdrawn. By the new rules published (in terms of the Acts of Settlement and Explanation) in 1672 resident traders were permitted to become freemen, but neither this regulation nor the ordinary admissions through birth, marriage, and apprenticeship succeeded in giving to Ireland free and vigorous municipalities. The corrupt admission of non-resident freemen, in order to outvote the ancient freeholders in parliamentary elections, and the systematic exclusion of Roman Catholics, soon divorced the "commonalty" from true local interests, and made the corporations, which elected themselves or selected the constituency, dangerously unpopular.

In Scotland burghs or burrows are divided into Royal Burghs, Burghs of Regality, and Burghs of Barony. The first were erected by Royal Charter, and every burgess held direct of the Crown. It was, therefore, impossible to subfeu the burgh lands,—a distinction still traceable in modern conveyancing. Where perhaps no charter ever existed, the law on proof of immemorial possession of the privileges of a Royal Burgh has presumed that a charter of erection once existed. The charter gave power to elect provost, bailies (French terms which superseded the ancient mayor and aldermen), and council, a power long exercised under the Act 1469, which directs the new council to be chosen annually by the retiring council, and the magistrates by both councils. The jurisdiction of these magistrates, which was specially reserved in the Act of 1747 abolishing heritable jurisdictions, was originally cumulative with, and as large as, that of the sheriff. It is now confined to police offences, summary ejections, orders for *interim* aliment (for prisoners), payment of burgh dues, and delivery of title deeds. Three head courts were held in the year, at which all burgesses were obliged to attend, and at which public business was done and private transactions were ratified. There were three classes of burgesses—burgesses *in sua arte*, members of one or other of the corporations; burgesses who are guild brothers; and simple burgesses. The Leges Burgorum apparently contemplate that all respectable inhabitants should have the franchise, but a ceremony of admission was required, at which the applicant swore fealty and promised to watch and ward for the community, and to pay his "maill" to the king. These borough maills, or rents, and the great and small customs of burghs, formed a large part of the royal revenue, and, although frequently leased or feued out for a fixed duty, were on the accession of James I. annexed to the Crown as an alimentary fund. Burgh customs still stand in the peculiar position of being neither adjudgeable nor arrestable; they are therefore bad security. The early charters contain the usual privileges of holding a market, of exemption from toll or tribute, and that distraint will be allowed only for the burgess's own debts. There was also the usual strife between the guildry and the craftsmen, who were generally prohibited from trading, and of whom dyers, fleshers, and shoemakers were forbidden to enter the guildry. Deacons, wardens, and visitors were appointed by the crafts, and the rate of wages was fixed by the magistrates. The crafts in Scotland were frequently incorporated, not by Royal Charter, but, as in the case of the cordiners of Edinburgh, by seals of cause from the corporation. The trade history of the free burghs is very important. Thus in 1466 the privilege of importing and exporting merchandize was confined to freemen, burgesses, and their factors. Ships are directed to trade to the king's free burghs, there to pay the customs, and to receive their *cocquets* or custom-house seals; and in 1503 persons dwelling outside burghs are forbidden to "use any merchandize," or to sell wine or staple goods. An Act of 1633, erroneously called a *Ratification* of the Privileges of Burghs, extended these privileges of buying and selling to retail as well as wholesale trade, but restricted their enjoyment to Royal Burghs. Accordingly, in 1672, a general declaratory Act was passed confirming to the freemen in Royal Burghs the wholesale trade in wine, wax, silk, dyeing materials, &c., permitting

generally to all persons the export of native raw material, specially permitting the burgesses of Barony and Regality to export their own manufactures, and such goods as they may buy in "markets," and to import against these consignments certain materials for tillage, building, or for use in their own manufactures, with a general permission to retail all commodities. This extraordinary system was again changed in 1690 by an Act which declared that freemen of Royal Burghs should have the sole right of importing everything by sea or land except bestial, and also of exporting by sea everything which was not native raw material, which might be freely exported by land. The gentry were always allowed to import for their personal consumption and to export an equal quantity of commodities. The Act mentions that the Royal Burghs as an estate of the kingdom contributed one-sixth part of all public impositions, and were obliged to build and maintain prison-houses. Some of these trade privileges were not abolished till the Act 9 and 10 Vict. c. 17.

In the north of Scotland there was an association of Free Burghs called the Hanse or *Ansus;* and the Lord Chamberlain, by his *Iter*, or circuit of visitation, maintained a common standard of right and duties in all burghs, and examined the state of the "common good," the accounts of which in 1535 were appointed to be laid before the auditors in Exchequer. The Chamberlain latterly presided in the Curia Quatuor Burgorum (Edinburgh, Berwick, Stirling, Roxburgh), which not only made regulations in trade, but decided questions of private right (*e.g.*, succession), according to the varying customs of burghs. This court frequently met at Haddington; in 1454 it was fixed at Edinburgh. The more modern Convention of Royal Burghs (which appeared as a judicial *persona* in the Court of Session so late as 1839) probably dates from the Act of James III. (1487, c. 111), which appointed the Commissioners of Burghs, both north and south, to meet yearly at Inverkeithing "to treat of the welfare of merchandize, the good rule and statutes for the common profit of burghs, and to provide for remeid upon the skaith and injuries sustained within the burghs." Among the more important functions of this body (on whose decrees at one time summary diligence proceeded) were the prohibition of undue exactions within burghs, the revisal of the "set" or mode of municipal election, and the *pro rata* division among the burghs of the parliamentary subsidy required from the Third Estate. The Convention still meets, but the reform of the municipalities, and the complete representation of the mercantile interests in the United Parliament, have deprived it of importance. In its great days it negotiated a treaty with Campvere, and one of its judgments was given effect to by Edward I. in the Parliament of Newcastle, 1292.

Burghs of Regality and of Barony held in vassalage of some great lordship, lay or ecclesiastical, but were always in theory or in practice created by Crown grant. They received jurisdiction in civil and criminal matters, generally cumulative with that of the Baron or the Lord of Regality, who in some cases obtained the right of nominating magistrates. Powers to hold markets and to levy customs were likewise given to these Burghs.

The Scotch burghs emerged slowly into political importance. In 1295 the procurators of six burghs ratified the agreement for the marriage of Edward Balliol; and in 1326 they were recognized as a Third Estate, granting a tenth penny on all rents for the king's life, if he should apply it for the public good. The Commissioners of Burghs received from the Exchequer their costages or expenses of attending Parliament. The burghs were represented in the Judicial Committee, and in the Committee on Articles appointed during the reign of James V. After the Reformation, in spite of the annexation of kirk lands to the Crown, and the increased burdens laid on temporal lands, the proportion of general taxation borne by the burghs (viz., 1s. 6d.) was expressly preserved by Act 1587, c. 112. The number of commissioners, of course, fluctuated from time to time. Cromwell assigned ten members to the Scotch burghs in the second Parliament of Three Nations (1654). The general practice until 1619 had been, apparently, that each burgh should send two members. In that year (by an arrangement with the Convention of Burghs) certain groups of burghs returned one member, Edinburgh returning two. Under Art. 22 of the Treaty of Union the number of members for Royal Burghs was fixed at fifteen, who were elected in Edinburgh by the Magistrates and Town Council, and in the groups of burghs by delegates chosen *ad hoc*. See PARLIAMENT. (See Connel, *History of the Constitution of Towns;* Stubbs, *Constitutional History of England*, vol. i.) (W. C. S.)

BOROUGH-ENGLISH, a custom prevailing in certain ancient boroughs, and in districts attached to them (where the lands are held in socage), and also in certain copyhold manors (chiefly in Surrey and Middlesex), by which in general lands descend to the youngest son, to the exclusion of all the other children, of the person dying seized and intestate. Descent to the youngest brother to the exclusion of all other collaterals, where there is no issue, is sometimes included in the general definition, but this is really a special custom to be proved from the Court-Rolls of the manor and from local reputation,—a custom which is sometimes extended to the youngest sister, uncle, aunt. Generally, however, Borough-English, apart from specialties, may be said to differ from gavel-kind in not including collaterals. It is often found in connection with the distinct custom that the widow shall take as dower the whole and not merely one-third of her husband's lands. (See Third Report of Real Property Commission, and case of Muggleton *v.* Barnett, 2 Hurls. and Nor. Rep.)

BOROVICHI, a town of Russia, in the government of Novgorod, situated in 58° 23′ N. lat. and 23° 54′ E. long., on both banks of the River Msta. On the site of the present town there existed, from an early date, a settlement famous for the skill of its pilots; and for their encouragement in that occupation the inhabitants were freed from taxation by Peter I. In 1770 the village was raised to the rank of a town, and in 1776 was made the head of a department in the Novgorod government. It contains seven or eight churches and a monastery, an almshouse, and a hospital. Flour, malt, beer, tallow, earthenware, and bricks are all manufactured, but none of them to any great extent. The principal articles of trade are linen, leather, and wood. There are two annual fairs, and a weekly market. Population in 1867, 9108.

BOROVSK, a town of Russia, in the government of Kaluga, 54 miles from that city on the old post road to Moscow, is situated on both banks of the Protva at the confluence of the Tikizh, in 55° 13′ N. lat. and 36° 9′ E. long. The town was in existence in the 13th century, and derived its name from the Borh, or pine forest, which still lies to the N.W. Its principal industries are tanning, soap-boiling, and the manufacture of wax, linseed-oil, and pottery; and it has a trade of considerable importance in grain, hemp, and cloth. There are four annual fairs, two of which are held in the town and two about two miles off, at the monastery of Paphnutius, which was founded in 1444. The population, mainly belonging to the Greek Church, was in 1860, 8150.

BORROMEAN ISLANDS, a group of four small islands on the western side of Lago Maggiore, in Northern Italy, beautifully surrounded by lake and mountain. Naturally mere barren rocks, they were in 1671 converted by Vitaliano Borromeo into pleasure gardens of great

beauty, the soil being transported from the neighbouring shores of the lake. The two most celebrated are the Isola Bella and the Isola Madre. The former rises 130 feet above the level of the water, in ten successive terraces, the highest of which is paved and surrounded by a balustrade, while all are environed by gigantic marble statues of various figures, and the walls are clothed with the finest fruit-trees and evergreens. There is, besides, towards the western end of the island, and close to the lake, a magnificent palace, built on arches, which are formed into grottos, with floors of mosaic and decorations of shell-work and marble. Isola Madre, which is the largest of the group, lies between one and two miles from Isola Bella, and consists of a superstructure of seven terraces, not less beautiful than the other. Here also there is a palace, now dilapidated, with similar decorations. A richly-coloured description of the place is given in his "Titan," by Jean Paul Richter.

BORROMEO, Carlo, saint and cardinal of the Roman Catholic Church, was the son of Ghiberto Borromeo, count of Arona, and of Mary of Medici, and was born at the Castle of Arona, upon the Lago Maggiore, in the Milanese, October 2, 1538. When he was about twelve years old, Julius Cæsar Borromeo resigned to him an abbacy, the revenue of which he applied wholly in charity to the poor. He studied the civil and canon law at Pavia under the learned Francis Alciat. In 1554 his father died; and, although he had an elder brother, Count Frederick, he was requested by the family to take the management of their domestic affairs. After a time, however, he resumed his studies, and in 1559 he took his doctor's degree. In the following year his uncle Cardinal de' Medici was raised to the pontificate, by the name of Pius IV.; and Borromeo was made prothonotary, entrusted with both the public and privy seal of the ecclesiastical state, created cardinal deacon, and soon after raised to the archbishopric of Milan. In compliance with the pope's desire, he lived in great splendour; yet his own temperance and humility were never brought into question. He established an academy of learned persons, and published their memoirs as the *Noctes Vaticanæ*. About the same time he also founded and endowed a college at Pavia, which he dedicated to Justina, virgin and martyr. Upon the death of his elder brother Frederick, his friends advised him to quit the church and marry, that his family might not become extinct. Contrary to expectation, however, he declined the proposal; and from that time became more fervent than ever in exercises of piety, and more zealous for the welfare of the church.

On the death of Pius IV., January 7, 1566, the skill and diligence of Borromeo materially contributed to stifle the cabals of the conclave. As soon as tranquillity had been re-established he devoted himself wholly to the reformation of his large and important diocese, where the most flagitious irregularities were openly practised. He began by making pastoral visits in his metropolis; and by a variety of wise and necessary regulations, he soon restored proper decency and dignity to divine service. In conformity to the decrees of the Council of Trent, he cleared the cathedral of its gorgeous tombs, rich ornaments, banners, arms, not even sparing the monuments of his own relations. He also divided the nave of the church into two compartments for the separation of the sexes. He proceeded next to the collegiate churches, and even to the fraternities of penitents, particularly that of St John the Baptist. The reformation of the monasteries followed that of the churches; and the vigilance of the archbishop soon extended itself from the city to the country round it. The great abuses which had overrun the church at this time arose principally from the ignorance of the clergy. In order, therefore, to attack the evil at its root, Borromeo established seminaries, colleges, and communities, for the education of young persons intended for holy orders. He met with much opposition in his endeavours to bring about his reforms, but succeeded, nevertheless, in rendering the most important services to the cause of morals as well as religion. The governor of the province, and many of the senators, apprehensive that the cardinal's ordinances and proceedings would encroach upon the civil jurisdiction, addressed many remonstrances and complaints to the courts of Rome and Madrid. But Borromeo had more formidable difficulties to struggle with, in the inveterate opposition of several religious orders, particularly that of the Brothers of Humility. Some members of that society formed a conspiracy against his life, and a shot was one evening fired at him in the archiepiscopal chapel under circumstances which led to the belief that his escape was miraculous.

In the year 1576 the city and diocese of Milan were visited by the plague, which swept away great numbers. On this occasion he went about giving directions for accommodating the sick and burying the dead, avoiding no danger, and sparing no expense. He also visited all the neighbouring parishes where the contagion raged, distributing money, providing accommodation for the sick, and punishing those, especially the clergy, who were remiss in discharging the duties of their calling.

But continual labours and austerities appear to have shortened his life. He was seized with an intermittent fever, and died at Milan, November 4, 1584. He was immediately enrolled among the saints, but was not canonized till 1610. Besides the *Noctes Vaticanæ*, to which he appears to have contributed, the only literary relics of this intrepid and zealous reformer are some homilies, discourses, and sermons, with a collection of letters. Several lives of him have been published,—by Godeau; by Touron, a Dominican; by Ribadeneira, a Spanish Jesuit; by Bimeus, and by others.

BORROMINI, Francesco, an Italian architect, born at Bissone in 1599. He was much employed in the middle of the 17th century at Rome. In his style he affected originality and richness, which corrupted the noble simplicity of the older schools, though his compositions are occasionally imposing. His principal works are the church of St Agnese in Piazza Navona, the church of La Sapienza in Rome, the church of San Carlino alle Fontane, the church of the Collegio di Propaganda, and the restoration of San Giovanni in Laterano. He died by his own hand at Rome in 1667. Engravings of his chief compositions are to be found in the posthumous work *Francisci Borromini opus Architectonicum*, 1727.

BORROWSTOUNNESS (usually abbreviated to Bo'ness), one of the oldest seaports of Scotland, is situated on the Firth of Forth, in Linlithgowshire, about four miles from the county town, in 56° 2′ N. lat. and 3° 35′ W. long. The town is very irregularly built, contrasting unfavourably with the beauty of its situation. It was formerly a place of considerable traffic, ranking in the 18th century immediately after Leith; but it has been for a long time left far behind by the neighbouring seaport of Grangemouth. Its harbour, with an area of 2½ acres, being too small for the trade of the port, a bill has been passed in Parliament for a large extension. The commerce is now for the most part confined to the Baltic, and the principal import consists of wooden props for use in mines. The value of the total imports in 1873 was £150,059, and of the total exports in the same year £223,539. There are extensive manufactories of salt, distilleries, a pottery, ropeworks, and vitriol and soap-works; but the collieries and iron-stone pits in the immediate neighbourhood are much more important. Some of the former have been worked for

centuries, and extend under the firth to the distance of a mile. The smelting of the iron-ore is carried on in two or three blast-furnaces in the neighbourhood of Kinniel House, which was for many years the residence of Dugald Stewart. A part of Graham's Dyke, the Roman wall of Antoninus, runs through the parish. Population in 1871, 4256.

BORY DE SAINT-VINCENT, JEAN BAPTISTE GEORGE-MARIE, a learned and industrious French naturalist, was born at Agen in 1780. While a mere boy he displayed the scientific bent of his genius and attracted attention by two memoirs addressed to the Society of Natural History at Bordeaux. Having been sent as naturalist of Baudin's expedition to Australia in 1798, he left the vessel at the Mauritius, and spent two years in exploring Bourbon and the other islands of East Africa. Joining the army on his return, he was present at the battles of Ulm and Austerlitz, and in 1808 went to Spain with Marshal Soult. His attachment to the Napoleonic dynasty and dislike to the Bourbons were shown in various ways during 1815, and his name was consequently placed on the list of the proscribed; but after wandering in disguise from one city to another he was allowed quietly to return to Paris in 1820. In 1829 he was placed at the head of a scientific expedition to the Morea, and in 1839 he had charge of the exploration of Algeria. Through all the vicissitudes of his life his literary activity was great, and he did a great deal for the popularization of his favourite science. He was editor of the *Dictionnaire classique d'histoire naturelle*, and one of the principal authors of the *Annales des sciences physiques*; the official work on the Morea was produced under his care, and he contributed frequently to periodical publications. The most important of his separate productions are—*Essais sur les îles Fortunées*, 1803; *Voyage dans les îles d'Afrique*, 1804; *Justification de la conduite et des opinions politiques de J. B. Bory de Saint-Vincent*, 1816; *Voyage Souterrain*, being an account of the quarries in the neighbourhood of Maestricht, 1823; *L'Homme, essai zoologique sur le genre humain*, 1827; *Résumé de la géographie de la Péninsule*, 1838.

BOSA, a city on the western coast of the island of Sardinia, in the province of Cagliari and district of Oristano, in a fine valley on the northern bank of the Terno, in 40° 16' 10" N. lat. and 8° 25' 31" E. long. It is the see of a bishop, and has a cathedral and a diocesan seminary. The harbour is safe, being sheltered by an islet. Coral fishery is carried on, and there is trade in cheese, grain, and wine. Population, 6706.

BOSC, LOUIS AUGUSTINE GUILLAUME, French naturalist, was born at Paris on the 29th January 1759. He was educated at the college of Dijon, and attended the lectures of Durande on botany, which inspired him with a passion for natural history. He followed up his studies at Paris, and was a constant auditor at the Jardin des Plantes. Even when closely occupied in official work, he managed to find time for his favourite researches and contributed many valuable papers to various scientific transactions and reviews. At the age of eighteen he had obtained an appointment under Government, and he rose to be one of the chief officials in the postal department. Under the ministry of Roland he also held the post of superintendent of prisons, but the violent outbreaks of 1793 drove him from office, and compelled him to take refuge in flight. For some months he lay concealed in the forest of Montmorency, barely subsisting on roots and vegetables. He was enabled to return to Paris on the fall of Robespierre, and soon after set out for America, resolving to explore the natural riches of that country. The immense materials he gathered were never published in a complete form, but much went to enrich the works of Lacépède, Latreille, and others. After his return, on the establishment of the Directory, he was reinstated in his old office. Of this he was again deprived by the *coup d'état* of 1799, and for a time he was in great destitution. He set resolutely to work, however, and by his copious contributions to scientific literature, contrived to support himself and to lay the foundations of a solid reputation. He was engaged on the Supplement to Rozier's Dictionary, on the new *Dictionnaire d'histoire naturelle*, and on the *Encyclopédie Méthodique*. He edited the *Dictionnaire raisonné et universal d'agriculture*, and was one of the editors of the *Annales de l'agriculture Française*. His increasing fame brought him manifold employments. He was made inspector of the gardens at Versailles, and of the public nurseries belonging to ministry of the Interior. The last years of his life were devoted to an elaborate work on the vine, for which he had amassed an immense quantity of materials. His death, on the 10th July 1828, prevented the prosecution of this work; and his notes which still exist are said to be so unsystematic as to be unfit for publication.

BOSCAN, JUAN, a Spanish poet, celebrated as the introducer of Italian measures into Spanish literature, was born about the close of the 15th century. The exact date is unknown, but it was probably a few years before 1500. He was of patrician birth and appears to have passed some years in military service. He died in 1540 at Perpignan, where he was residing with the duke of Alva. His poems were published in 1543 at Barcelona by his widow. They are divided into four books which mark out distinctly the stages of Boscan's poetical history. The first book contains light poems in the Old Castilian metres, resembling the *Cancioneros*. These were written in his youth, before 1526, in which year he became acquainted with Andrea Navagiero, ambassador from Venice. Navagiero urged him to adopt some of the Italian measures, and his advice gave a new turn to Boscan's activity. The second and third books contain a number of pieces in Italian metres, sonnets, canzones, and poems in blank verse, *terza rima*, and octaves. The longest of these poems is the *Hero and Leander*, in blank verse. The fourth book contains his best effort, the *Allegory*, written in the maturity of his powers, and exhibiting great delicacy of imagination and skilful verse composition. He also published, in 1534, a translation of Balthasar Castiglione's Italian poem *The Courtier*. Boscan's greatest follower in the endeavour to mould Spanish poetry after Italian models was Garcilassa de la Vega, who is more celebrated than his master.

See Bouterwek, *Spanish Literature*, vol. i.; Ticknor, *History of Spanish Literature*, vol. i.

BOSCAWEN, EDWARD, British admiral, was born August 19, 1711. He was the third son of Hugh, Lord Viscount Falmouth. He early entered the navy, and in 1740 distinguished himself at the taking of Porto Bello. At the siege of Carthagena, in March 1741, at the head of a party of seamen, he took a battery of fifteen 24-pounders, while exposed to the fire of another fort. On his return to England in the following year he married, and entered parliament as member for Truro. In 1744 he captured the "Medea," a French man-of-war, commanded by M. de Hocquart, the first ship taken in the war. In May 1747 he signalized himself in the engagement off Cape Finisterre, and was wounded in the shoulder with a musket-ball. Hocquart again became his prisoner and the French ships, ten in number, were taken. On the 15th July, he was made rear-admiral and commander-in-chief of the expedition to the East Indies. On the 29th July 1748 he arrived off Fort St David's, and soon after laid siege to Pondicherry; but the sickness of his men and the approach of the monsoons led to the raising of the siege. Soon afterwards he received news of the peace, and Madras was delivered up to him by the French. In April 1750

he arrived in England, and was the next year made one of the lords of the Admiralty, and chosen an elder brother of the Trinity House. In February 1755 he was appointed vice-admiral, and in April he intercepted the French squadron bound to North America, and took the "Alcide" and "Lys" of sixty-four guns each. Hocquart became his prisoner for the third time, and Boscawen returned to Spithead with his prizes and 1500 prisoners. For this exploit he received the thanks of Parliament. In 1758 he was appointed admiral of the blue and commander-in-chief of the expedition to Cape Breton, when, in conjunction with General Amherst, he took the fortress of Louisbourg, and the island of Cape Breton,—services for which he again received the thanks of tho House of Commons. In 1759, being appointed to command in the Mediterranean, he pursued the French fleet, and after a sharp engagement in Lagos Bay, took three large ships and burnt two, returning to Spithead with his prizes and 2000 prisoners. In December 1760 he was appointed general of the marines, with a salary of £3000 per annum, and was also sworn a member of the privy council. He died at his seat near Guildford, January 10, 1761, in the 50th year of his age.

BOSCOVICH, Roger Joseph, a distinguished Italian mathematician and natural philosopher, and one of the earliest of foreign *savants* to adopt the theory of Newton, was born at Ragusa in Dalmatia, May 18, 1711, according to the usual account, but ten years earlier according to Lalande (*Éloge*, 1792). In his fifteenth year, after passing through the usual elementary studies, he entered the society of Jesus. On completing his noviciate, which was spent at Rome, he studied mathematics and physics at the Collegium Romanum; and so brilliant was his progress in these sciences that in 1740 he obtained the appointment of professor of mathematics in the college. For this post he was especially fitted by his large acquaintance with modern advances in science and by his skill in a classical severity of demonstration, acquired by a thorough study of the works of the Greek geometricians. Several years before this appointment he had made himself a name by an elegant solution of the problem to find the sun's equator and determine the period of his rotation by observation of the spots on his surface. Notwithstanding the arduous duties of his professorship he found time for investigation in all the fields of physical science; and he published a very large number of dissertations, some of them of considerable length, on a wide variety of subjects. Among these subjects were the transit of Mercury, the Aurora Borealis, the figure of the earth, the observation of the fixed stars, the inequalities in terrestrial gravitation, the application of mathematics to the theory of the telescope, the limits of certainty in astronomical observations, the solid of greatest attraction, the cycloid, the logistic curve lines, the theory of comets, the tides, the law of continuity, the double refraction micrometer, various problems of spherical trigonometry, &c. In 1742 he was consulted, with other men of science, by the pope, Benedict XIV., as to the best means of securing the stability of the dome of St Peter's, in which a crack had been discovered. His suggestion was adopted. Shortly after he engaged to take part in the Portuguese expedition for the survey of Brazil and the measurement of a degree of the meridian; but he yielded to the urgent request of the pope that he would remain in Italy and undertake a similar task there. Accordingly, in conjunction with Christopher Maire, an English Jesuit, he measured an arc of two degrees between Rome and Rimini. The operations were begun towards the close of 1750, and were completed in about two years. An account of them was published in 1755, entitled *De Litteraria expeditione per pontificam ditionem ad dimetiendos duos meridiani gradus a P. P. Maire et Boscovich.* The value of this work was increased by a carefully prepared map of the States of the Church. A French translation appeared in 1770. A dispute having arisen between the Grand Duke of Tuscany and the republic of Lucca with respect to the drainage of a lake, Boscovich was sent, in 1757, as agent of Lucca to Vienna, and succeeded in bringing about a satisfactory arrangement of the matter. In the following year he published at Vienna his famous work on the molecular theory of matter, entitled *Theoria philosophiæ naturalis redacta ad unicam legem virium in natura existentium.*• Another occasion for the exercise of his diplomatic ability soon after presented itself. A suspicion having arisen on the part of the British Government that ships of war had been fitted out in the port of Ragusa for the service of France, and that the neutrality of Ragusa had thus been violated, Boscovich was selected to undertake an embassy to London (1760), to vindicate the character of his native place and satisfy the Government. This mission he discharged successfully, with credit to himself and satisfaction to his countrymen. During his stay in England he was elected a fellow of the Royal Society, which received him with marks of the highest respect. He soon after paid this society the compliment of dedicating to it his Latin poem, entitled, *De Solis et Lunæ Defectibus.* This prolix composition, one of a class which at that time was much in vogue—metrical epitomes of the facts of science—contains in about five thousand lines, illustrated by voluminous notes, a compendium of astronomy. It was for the most part written on horseback, during the author's rides in the country while engaged in his meridian measurements. The book is characterized by Delambre as "uninstructive to an astronomer and unintelligible to any one else."

On leaving England Boscovich travelled in Turkey, but ill health compelled him soon to return to Italy. In 1764 he was called to the chair of mathematics at the University of Pavia, and this post he held, together with the directorship of the observatory of Brera, for six years. He was invited by the Royal Society of London to undertake an expedition to California to observe the transit of Venus in 1769; but this was prevented by the recent decree of the Spanish Government for the expulsion of the Jesuits from its dominions. The vanity, egotism, and petulance of Boscovich provoked his rivals and made him many enemies, so that in hope of peace he was driven to frequent change of residence. About 1770 he removed to Milan, where he continued to teach and to hold the directorship of the observatory of Brera; but being deprived of his post by the intrigues of his associates he was about to retire to his native place, when the news reached him (1773) of the suppression of his order in Italy. Uncertainty as to his future lot led him to accept an invitation from the king of France to Paris, where he was naturalized and was appointed director of optics for the marine, an office instituted for him, with a pension of 8000 livres. He remained there ten years, but his position became irksome, and at length intolerable. He continued however to devote himself diligently to the pursuits of science, and published many remarkable memoirs. Among them were an elegant solution of the problem to determine the orbit of a comet from three observations, and memoirs on the micrometer and achromatic telescopes. In 1783 he returned to Italy, and spent two years at Bassano, where he occupied himself with the publication of his *Opera pertinentia ad opticam et astronomiam, &c.*, which appeared in 1785 in five volumes quarto. After a visit of some months to the convent of Vallombrosa, he went to Milan and resumed his literary labours. But his health was failing, his reputation was on the wane, his works did not sell, and he gradually sank a prey to illness and disappointment. He fell into

melancholy, imbecility, and at last madness, with lucid intervals, and died at Milan on the 13th of February 1787. In addition to the works already mentioned Boscovich published *Elementa universæ matheseos* (1754), the substance of the course of study prepared for his pupils; and a narrative of his travels, entitled *Giornale di un viaggio da Constantinopoli in Polonia*, of which several editions and a French translation appeared. His latest labour was the editing of the Latin poems of his friend Benedict Stay on the philosophy of Descartes, with scientific annotations and supplements. (W. L. R. C.)

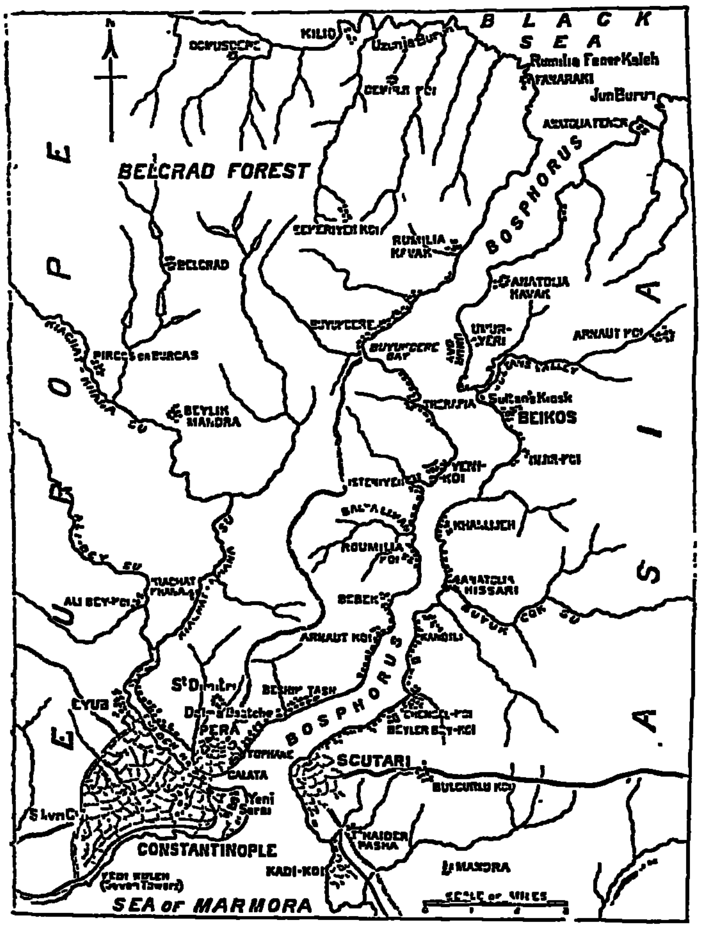
BOSNA SERAI, SERAIEVO, or in Italian SERAGLIO, a city of European Turkey, and capital of the province of Bosnia, is situated on the Migliazza near its junction with the Bosna, 246 miles south of Buda in 43° 54′ N. lat. and 18° 24′ E. long. It occupies the declivities of several small hills, and its numerous turrets give it a rather imposing aspect. It is defended by a strong citadel, and retains portions of its ancient walls. The houses are in general rather meagre, but of late there has been an improvement in the style of architecture, owing to the employment of Austrian and Italian workmen. The old Government buildings have been replaced by a handsome and spacious structure. There are upwards of 100 mosques, several Greek churches, and a few Roman Catholic convents. Educational establishments owe any merit they possess to foreign influence, and notably to the stimulus given by Miss Irby and Miss Mackenzie (afterwards Lady Sebright). Bosna Serai is one of the chief industrial and commercial cities in European Turkey. It manufactures tin, iron, and copper wares, fire-arms, cotton and woollen cloths, and leather, and is the centre of the Bosnian trade. In the neighbourhood are iron mines, and works of considerable extent. The city is the centre of a telegraphic system of some importance, and is well situated for railway communication with both north and south. Bosna Serai, originally called Bosnavar, was founded in 1263 by the Hungarian general Cotroman, and derives its present name from the *Serai* or palace built by Mahomet II. The population is very variously stated; the Prussian consul gives it as about 50,000 in 1865, and in 1867 as not more than 35,000, while Salaheddin Bey, in *La Turquie à l'exposition universale de* 1867, states it as high as 70,000.

BOSNIA, the most north-westerly province of Turkey in Europe, comprising Bosnia Proper, a part of Turkish-Croatia, or Craina, the district of Herzegovina, and the ancient Rascia. It extends from 42° 30′ to 45° 15′ N. lat., and from 15° 40′ to 21° 2′ E. long; is bounded on the N. and W. by the Austrian dominions, S. by Montenegro and Albania, and E. by Servia; and has an area of about 24,024 square miles. The whole province, with the exception of the valley of the Save, is more or less mountainous, many of the summits reaching the height of 6000 feet. A large proportion of the surface is valuable forest-land, which furnishes almost inexhaustible stores of timber and fuel. Plums are largely grown in the northern portion and exported as prunes,—Beska on the Save being one of the chief centres of the trade. In Herzegovina the vine, olive, fig, and pomegranate flourish. Maize and wheat are the principal grains in cultivation, but barley, oats, hemp, and even rice are also grown. Abundance of pasture land occurs throughout the province, and cattle, sheep, and goats are reared; the number of the cattle was, however, greatly diminished by the plague in the decade ending with 1870. Large droves of swine are fed in the oak-forests. In mineral deposits the country is especially rich. The whole valley of the Bosnia is said to be one enormous coal-bed; copper is worked in several places, and at Inatch is a very valuable cinnabar mine. There are also some of the [illegible] good marble, and at Tuzla is a copious spring of salt water from which culinary salt is manufactured, though the demand for this article has still to be met by a foreign supply. The manufactures of the province are on a small scale; they include leather, cloth, and iron wares. The principal exports are fruit, timber, cattle, wool, raw lamb-skins, furs of wild animals, wax, and honey. The foreign trade is almost solely confined to the Austrian dominions,—the lack of a port on the Adriatic greatly impeding the intercourse by sea. Within the last ten years there have been constructed several carriage roads, the most important of which are from the capital to Brood, Gradishka, Mostar, and Yenibazar respectively. A railway has been constructed from Rasnice in Austria to Banyaluka, forming part of a great connecting line between Constantinople and Western Europe. The province is divided into the seven sandjaks of Banyaluka, Bihac, Herzegovina, Yenibazar, Seraievo, Travnik, and Zvornik. Ethnologically it is Servian, not even the aristocracy being Turks, though they are principally Mahometans. A small part of the south has an Albanian population. Mahometanism is not only predominant, but is sometimes enforced by persecution. Education is said to be greatly neglected, though from the native statistics a different judgment might be formed, no fewer than 1079 schools being *registered*; but of these a large proportion are attached to the mosques, and have a merely nominal existence. The total revenue of the province was, in 1871, 50,589,970 piastres (£456,715), and the expenditure, 19,724,745 (£178,070). The population increases very slowly, chiefly owing to mortality among the children occasioned by improper treatment. The climate is by no means unhealthy. The number of the inhabitants has remained almost stationary, being estimated at 1,100,000 in 1844, and at 1,279,296 in 1873. The largest cities after Bosna Serai, the capital, are Banyaluka (15,000), Fotcha, Mostar, Zvornik, and Travnik (about 12,000 each), and Yenibazar (from 9000 to 15,000). Bosnia was at first dependent on the Servian and Croatian kings, but was raised for a time to a separate principality, which reverted about 1339 to the Servian king Stephen. After his death it was again independent, and continued to have its own rulers till the latter half of the 15th century, in spite of the encroachments of the Turks, who at last succeeded in incorporating it in 1503. The Hungarians long disputed this appropriation, but the country was definitely ceded to Turkey at the peace of Carlovitz in 1699, which was confirmed by the treaty of Sistovar in 1791. It is at present (1875) the scene of a formidable insurrection.

See Chaumette Desfosse's *Voy. en Bosnie*, 1822; Pertusier, *La Bosnie*, 1822; Hilferding, *Bosnia, Herczegovina, i staraya Serbia* (in Russian) 1859; Sax, *Skizzen über die Bewohner Bosniens*, 1864; Roskievicz, *Bosnia und Herzegovina*, 1867; Blau in *Zeitschrift für Erdk.*, Berlin, 1868; Rousseau in *Bulletin de la Soc. de Géog.*, 1868; Maurer, *Reise d. Bosnien*, 1870; Geiger and Lebret, *Studien über Bosnien, etc.*, 1873; and a very full report by the English consul Holmes for 1872.

BOSPHORUS (or, more correctly, BOSPORUS, from the Greek Βόσπορος, Ox-ford), originally used for a strait, was especially applied to the *Bosporus Cimmerius*, or Strait of Yenikale, and the *Bosporus Thracius*, or Strait of Constantinople. In modern times it has almost become the exclusive designation of the latter strait, which unites the Black Sea with the Sea of Marmora and forms the boundary between Europe and Asia. The channel is about 16 English miles in length, and has a maximum breadth of nearly 2 miles, a minimum breadth of 550 yards, and along the middle a varying depth of 148 to 388 feet. In the centre there is a rapid current from the Black Sea to the Sea of Marmora, and a counter-current sets in along each shore. At the narrows the three currents produce a most violent commotion. The average temperature of the water hardly differs from that of the air, but it almost never

reaches the atmospheric maxima and minima. The surface is very rarely frozen over, not more than five or six instances being recorded since the 8th century A.D. The Golden Horn was partially frozen over in 1849 and 1862. The shores of the Bosphorus are composed in the northern portion of different volcanic rocks, such as dolerite, granite, and trachyte; but along the remaining course of the channel the prevailing formations are Devonian, consisting of sandstones, marls, quartzose conglomerates, and calcareous deposits of various kinds. The scenery on both sides is of the most varied and beautiful description.



Sketch-Map of the Bosphorus.

See Miss Pardoe's *The Bosphorus and the Danube*, 1839; Hammer, *Constantinopolis und der Bosporos*, 1822; Reisewitz, *Bosporos und Attika*, 1861; Tchihatchef, *Le Bosphore et Constantinople*, 1864, and *Asie Mineure* (Géographie physique comparée), 1852; Dethier, *Der Bosphor und Constantinopel*, 1873.

BOSSI, GIUSEPPE, an Italian painter and writer on art, was born at the village of Busto Arsizio in the Milanese, in 1776 or 1777. He was educated at the college of Monza; and his early fondness for drawing was fostered by the director of the college, who supplied him with prints after the works of Agostino Carracci for copies. Passing next to the academy of Brera at Milan, he there pursued his special artistic studies, and about 1795 went to Rome. Here he studied for five or six years, associating with many artists of the Italian school, and especially forming an intimate friendship with Canova. On his return to Milan he was named assistant secretary of the Academy of Fine Arts, and on the death of Bianconi succeeded him in the office of secretary. He rendered important service in the organization of this new institution. In 1804, in conjunction with Oriani, he drew up the rules of the three academies of art of Bologna, Venice, and Milan, and soon after was rewarded with the decoration of the Iron Crown. On the occasion of the visit of Napoleon I. to Milan in 1805, Bossi exhibited a drawing of the Last Judgment of Michael Angelo, and pictures representing Aurora and Night, Œdipus and Creon, and the Italian Parnassus. By command of Prince Eugene, viceroy of Italy, Bossi undertook to make a copy of the Last Supper of Leonardo, then almost obliterated, for the purpose of getting it rendered in mosaic. The drawing was made from the remains of the original with the aid of copies and the best prints. The mosaic was executed by Raffaelli, and was placed in the Imperial Gallery of Vienna. Bossi made another copy in oil, which was placed in the museum of Brera. This museum owed to him a fine collection of casts of great works of sculpture acquired at Paris, Rome, and Florence. Bossi devoted a large part of his life to the study of the works of Leonardo; and his last work was a series of drawings in monochrome representing incidents in the life of that great master. He left unfinished a large cartoon in black chalk of the Dead Christ in the bosom of Mary, with John and the Magdalene. In 1810 he published a special work in large quarto, entitled *Del Cenacolo di Leonardo da Vinci*, which had the merit of greatly interesting Goethe. His other works are *Delle Opinioni di Leonardo intorno alla simmetria de' corpi umani* (1811), and *Del Tipo dell' arte della pittura* (1816). Bossi died at Milan, December 15, 1816. A monument by Canova was erected to his memory in the Ambrosian library, and a bust was placed in the Brera.

BOSSI, GIUSEPPE CARLO AURELIO, BARON DE, an Italian poet and diplomatist, was born at Turin, November 15, 1758. He made his first appearance as poet at the age of eighteen by the publication of two tragedies, *Rea Silvia* and *I Circassi*; and four years later he took the degree of doctor of laws. In 1781, in consequence of his ode in praise of the edict of toleration promulgated by the Emperor Joseph II., he was banished the kingdom; but having rendered during his exile an important service to his countrymen he was recalled and appointed under-secretary of state for foreign affairs. In 1792, on occasion of the French invasion, he was sent to the court of Prussia to negotiate an alliance, and thence went as ambassador to St Petersburg. Dismissed by the emperor in consequence of the treaty of alliance between Sardinia and France (1797), he was named ambassador to Venice, which he reached only in time to witness the fall of the republic. He was next appointed envoy to General Bonaparte in Italy. After the conquest of Sardinia Bossi was a member of the Provisional Government, and one of the three deputies sent to Paris to petition for annexation to France. The Russian invasion of 1799 drove him to take refuge in the Vaudois valleys. He was afterwards a member of the Provisional Government, but retired in 1802. Three years later he was made prefect of the Ain, he was created baron by Napoleon I. in 1810, and was afterwards transferred to the prefecture of La Manche. Deprived on the second return of the Bourbons, he came to England, but returned to France the following year. He spent his remaining years in retirement. Besides the works above mentioned Bossi was author of a long poem entitled *Oromasia*, on the events of the French revolution; *Monaca*, a poem on the secularization of convents (1787); and various lyrical pieces, among which are *Independenza Americana* (1785), *Olanda Pacificata* (1788), *Visione* (1799), &c. He died at Paris, January 20, 1823.

BOSSU, RENÉ LE, an eminent French critic, born at Paris, March 16, 1631. He studied at Nanterre, and in 1649 entered among the regular canons of Sainte-Geneviève. After having acted as professor in different religious houses for twelve years, he withdrew into retirement. His first publication was *Parallèle des Principes de la Physique d'Aristote et de celle de René Descartes*, which appeared in 1674, but met with little success. His next work, entitled *Traité du Poëme Épique*, was published in

1675 and often reprinted afterwards. Its leading doctrine is that the subject should be chosen before the characters, and that the action should be arranged without reference to the personages who are to figure in the scene. Boileau, in his *Third Reflexion on Longinus*, pronounced this work "l'un des meilleurs livres de poétique qui, du consentement de tous les habiles gens, aient été faits en nôtre langue." It may be mentioned, however, that Bossu is said to have defended Boileau against Saint-Sorlin, and to have received his thanks for that service; and a sense of obligation may perhaps have dictated the commendation which Boileau bestowed on the work. Bossu died March 14, 1680.

BOSSUET, JACQUES BÉNIGNE, the celebrated orator and prelate, was born at Dijon, within a short distance of the cathedral, on the 27th September 1627. He was the fifth son of Bénigne Bossuet and Madeleine Mochette. The family of which he came, though of bourgeois rank, had long taken an honourable part in the public and official life of Burgundy. He was destined from infancy for the church, and grew up amid influences eminently favourable to the unfolding of his powers, for, although at six years of age, on his father's appointment to be president in the parliament of Metz, he was left at Dijon, yet his education had been wisely confided to an uncle, Claude Bossuet, a large-hearted man, ardently devoted to literature, whose delight it was to foster his nephew's intellectual gifts. These soon gave token of exceptional brilliancy, and in the Jesuits' College, where he went to school, he distanced all competitors in the facility with which he mastered the Greek and Latin classics, Virgil and Homer being his especial favourites, for whose writings he contracted an unalterable attachment, just as Horace became the life-long companion of his rival Fénélon. It was from a higher source, however, that Bossuet's genius, which was essentially of the Hebrew type, caught its finest inspiration; and one day reading a Bible left open by accident at the prophecies of Isaiah, he was so thrilled by their poetry that thenceforth he became virtually "a man of one book," and in Holy Scripture, read and re-read until learned ultimately almost by heart, he found the field in which his mind could best expatiate and gather light and power. In Bossuet, says Lamartine, the Bible was transfused into a man. With that keen-sighted appreciation of talent which they uniformly display, the Jesuits sought to enlist him in their order, but family influence being against the proposal, in 1642 he was sent to Paris; nor could the circumstances of his arrival there fail profoundly to impress the fervid imagination of the boy, for it chanced to be on the very day on which Richelieu, then near his end, was borne into the city in a splendid movable chamber, at the close of the vengeance-taking campaign, which terminated in the execution of De Thou. Bossuet entered the college of Navarre, the oldest in the University, where, under Nicholas Cornet, the presiding genius of the place, and in midst of the intellectual quickening imparted to it in common with the whole of learned Europe by the new philosophy of Descartes, he achieved distinction in every department except mathematics, for which he seems to have possessed neither the taste nor the faculty. At sixteen his attainments were the talk of the town. He became the pet of the lettered aristocracy of Paris, and it argues his strength of character that he was unspoiled by their caresses. The applause which greeted the delivery of his thesis for the bachelor's degree encouraged him to perfect his superb oratorical gifts, nor did he count it unlawful then to be a frequent spectator when the *chefs-d'œuvres* of Corneille were played, although, later, he was not sparing in his criticism of the stage. At twenty-four he was appointed archdeacon of Metz. In Lent 1652, after a season of retreat at St Lazare, he received priest's orders, and immediately quitted the gay capital, and the career already opening to him there, to fulfil the duties awaiting him in the comparative obscurity of the provinces. Six years were spent in unwearied pastoral activity, as well as in exhaustive private study of Scripture and of the Fathers, notably St Augustine, although even in the less read Patristic writings he was at home, and quickly put his knowledge to use in a work of controversy entitled *Refutation du Catechisme de Paul Ferry*, a Protestant minister of Metz. It is of interest principally because it outlines even at that early date the doctrine afterwards vigorously defended by Bossuet of the limited authority of the popes in matters of faith. The echo of his pulpit eloquence had already begun to reach beyond Lorraine; during a short residence at Metz it fascinated Anne of Austria, the Queen Mother, and for the next ten years (1659–69) he was in perpetual request in the metropolis. Wherever he appeared court and city flocked to listen; the queens went from the palace and the nuns of Port Royal from their seclusion; Condé, Turenne, Madame de Sevigné, and other famous contemporaries mingled with the crowd; while, in 1662, the preacher's triumph reached a climax, when after hearing him for the first time at the Louvre, Louis XIV., in a moment of rarely awakened enthusiasm, despatched a royal message to Bossuet's father—"pour le feliciter d'avoir un tel fils."

According to Lachet, these matchless discourses may be classified as belonging to three periods:—that of Metz, showing a considerable measure of crudeness both of thought and expression; that of Paris, distinguished by strength and splendour (for, as Sainte-Beuve observes, every trace of immaturity or questionable taste disappears from the moment when Bossuet enters the circle of the king's influence); and that of Meaux, in which faultless grace of composition is purchased at the expense of vigour. On ordinary occasions, and for an audience that loved the practical truths of religion marshalled with logical force and distinctness, Bourdaloue was, perhaps, equally attractive as a preacher—there is even more contemporary talk about him; but in the *Oraisons Funèbres* Bossuet is unapproachable. In this species of oratory Mascaron and Flechier had preceded him, but he is the veritable creator of it, and nowhere does his genius take such wing as at the grave's mouth, when, recounting the virtues of the illustrious dead, he pictures, with wonderful sweep of imagination and mastery of detail, the historical events and personages of the epoch in which they lived, the more impressively to demonstrate that all earthly pomp and renown "are shadows, not substantial things." Not that he altogether escapes the vice of the French pulpit of that age, for occasionally he does elevate into types of excellence those who fell far short of it; but, as compared with other offenders, the adulation which he offers is, even in the hearing of royalty, measured and temperate. His funeral orations at the death of Henrietta of England, of her daughter, the duchess of Orleans, and of the great Condé, are commonly deemed his finest efforts of the kind.

In 1669 Bossuet was appointed to the diocese of Condom, and in the year following he became preceptor to the Dauphin; but being unable, in conscience, to retain both offices he resigned the former, and, in consideration of the pecuniary sacrifice involved, obtained the revenues of the Abbey of St Lucien at Beauvais. Convinced that on the culture of the Dauphin might depend the future welfare of the French people, he threw himself with incredible energy into the novel duties of the preceptorship, and resumed his own education the better to educate his august but indolent pupil. He lacked that sweetness of nature, however, which afterwards gave to Fénélon such sway over the Dauphin's son. For the edification of his royal charge Bossuet wrote several able works, such as

L'Histoire abregée de la France; *La Politique sacrée*; *Traité de la connaissance de Dieu et de soimême*; and most celebrated of al., *Le Discours sur l'histoire universelle*. This work, originally meant to be a mere abridgment for use in the royal schoolroom, grew as he wrote into a magnificent historical narrative. It consists of three parts:—(1), a sketch of history from Genesis to the birth of the modern world under Charlemagne; (2), an account of the Mosaic and Christian economies; (3), a series of reflections on the vicissitudes of human government,—the whole being characterized by splendour of colouring and vast range of plan, although this latter feature is less striking in late editions than in the earliest, which was not broken up into chapters. In the composition of it Leibnitz greatly helped him, by forwarding from Germany every book bearing on the subject on which he could lay hands. Its central thought is that of all changes in history being overruled with sole reference to the progress and universality of true religion; but Bossuet's treatment of this theme, notwithstanding a host of striking and unchallengeable observations, is vitiated by his identification of the Christian faith exclusively with the Papal form of it, and by the way in which he ignores the place and value of pagan antiquity in the world's development, so as to invite, if not to justify, the sneer of Voltaire: "Il parait avoir écrit uniquement pour insinuer que tout a été fait dans le monde pour la nation juive."

It was not until the close of 1679 that Bossuet's official duties as preceptor came to an end, but in the interval his industry otherwise did not slacken. He was elected a member of the Academy of France in 1671. About this time, too, he gave to the world the most frequently revised, most bitterly attacked, and most widely translated of all his books, *L'Exposition de la doctrine catholique*. Composed in 1669, and originally circulated in manuscript, it had been credited with effecting in this shape not a few conversions, among others that of Turenne. But Jean Daillé and other Reformers having charged it with toning down the harshness of Roman dogma with the purpose of ensnaring their flocks, Bossuet resolved to publish it. The book created a wide-spread flutter of excitement, as may be inferred from the terms employed in speaking of it by Jurieu, perhaps the ablest of Bossuet's opponents,—"Everybody is gone mad over the *Exposition*; everywhere one hears of the most disgraceful perversions." It twice received the *imprimatur* of the Pope in despite of the author's undisguised opinions with respect to infallibility. Curiously enough, it was this treatise that brought about in 1678 the conference between Bossuet and Claude, the learned pastor of Charenton. Floquet informs us that wherever he could obtain a face to face encounter, Bossuet preferred it to controversial writing. On the present occasion the discussion lasted five hours, turning on the authority of the church, with what result is, perhaps, not unfairly described by Bayle in the pithy remark—"That as at the battle of Seneff, both sides claimed the victory."

During the latter years of the preceptorship Bossuet, with a few genial associates, busied himself with *Notes and Annotations of the Books of Scripture*. Many pleasant hours were spent in these round-table studies, and it is proof of his inexhaustible energy that he did not hesitate, even so late in life, to acquire a knowledge of Hebrew, though there may be a touch of exaggeration in what was said of him by an admirer,—"that he was not less familiar with the language of Moses than with that of Homer." His life at court was not without its shadows. His very position involved him unwillingly in the miserable transactions springing out of the unhallowed relation in which the king stood to his successive favourites. But Bossuet never forgot the bishop in the courtier. He remonstrated often and seriously with the profligate Louis. As spiritual adviser of the beautiful but unhappy La Vallière, his Christian gentleness and wisdom shine out conspicuously in the interviews and correspondence which issued in her retirement to the convent of the Carmelites. If, in the case of Madame de Montespan, his actions are more open to misconstruction, yet further investigation tends towards his acquittal of the charges advanced by various historians.

Appointed in 1681 to the bishopric of Meaux, Bossuet had scarcely been installed when he was summoned to take part in the memorable assembly of the French clergy with which his name will always be associated. This council was convoked by royal edict, at the instance of the clergy themselves, for the purpose of finding a way out of the conflict, yearly growing fiercer, between Louis and Rome. The strife arose about the *regalia*, or claim of the Crown to administer the affairs of a vacant see until such time as its new occupant should take the oath of fidelity. But in the course of its discussions the council was agitated by questions far wider than that in which it took its rise, and embracing eventually the whole subject of the extent and limits of Papal authority. Bossuet preached the opening sermon. He gave fearless utterance to his cherished opinions. Referring to the aggressive disposition of the Papacy he declared—"Ocean itself, immense though it is, has its limits, and to break through at its own caprice would be to lay desolate the world." At the same time, seeing the heated state of the public mind, he counselled moderation, occupying a middle place between Ultramontanists and ultra-Gallicans, and was even opposed to any formal declaration of the Gallican position. Being overruled in this chiefly through the influence of Harlay, archbishop of Paris, he next directed his efforts towards issuing the assembly's decision in the most temperate and conciliatory form. He was himself appointed to draw it up, and there resulted the famous four articles which were in substance these:—I. The civil authority is not subject to the ecclesiastical in temporal things; II. As decreed by the Council of Constance, a general council is superior to the Pope; III. The exercise of the apostolic power ought to be tempered by the usage of particular churches; IV. Except with the consent of the church the judgment of the Pope is not unalterable in matters of faith. Being virulently attacked, these propositions were defended by Bossuet in his great *Defense de la doctrine du clergé de France*, which, however, was not printed until 1735.

Bossuet applauded the shameful revocation of the Edict of Nantes (1685), but his English biographer reminds us that, stern as was his character, he did his utmost to secure to Protestants as much liberty as was possible under the existing law; and, further, that no military execution took place during his episcopate at Meaux.

In 1688 there appeared *L'Histoire des Variations des Églises Protestantes*, a review and analysis, in fifteen books, of the confessions of faith emitted by Protestant churches during the epoch of the Reformation, in which Bossuet aims at demonstrating their incoherency and self-contradiction, even on cardinal points, as contrasted with the doctrinal stability of Rome. Forcible and learned as it undoubtedly is, this work is grievously lacking in candour, and in the paramount love of truth, the treatment of Luther and his writings being especially unscrupulous and vindictive. Indeed, from first to last, it is executed in the spirit less of an upright judge than of an unprincipled partisan. These less attractive features of Bossuet's character, over which one would gladly throw the veil, became still more prominent when in 1689 there broke out the bitter quarrel on the subject of "Quietism," the melancholy and fluctuating history of which may be best embraced

under that of Fénélon. Bossuet, by his attitude, alike unjust and ungenerous, has left an indelible stain upon his otherwise brilliant reputation, while the man for whose condemnation he resorted to violence and intrigue conducted himself with the meekness and charity of a saint. Attacked by a painful disorder, of which the premonitory symptoms appeared in 1696, the venerable prelate lingered on until the 12th of April 1704, when he died at Paris in his 77th year, amid the tokens of universal regret.

Of unrivalled eloquence and consummate learning, an intrepid controversialist and defender of the faith, as well as the most conscientious and diligent of bishops, he will probably be remembered longest as the champion of the ancient rights and liberties of the Gallican Church, and the representative of a phase of catholicism which the Vatican council has for ever banished from within the Roman pale.

The best edition of Bossuet's works is that of Lachat in thirty-one vols., Paris (Vives). See also *Life of Bossuet*, by Cardinal de Bossuet; *Studies of his Life*, by Floquet; and the *Memoirs* of the Abbé le Dieu. There is a full and admirable English *Life of Bossuet*, by the author of the *Life of St Francis de Sales*, 1874. For Brougham's estimate of Bossuet as an orator, which is very depreciatory, see his *Works*, iii. 262–269. For a criticism of *L'Histoire Universelle* see Flint's *Philosophy of History*. (A. B. C.)

BOSTON, a parliamentary and municipal borough and seaport town of England, in the county of Lincoln and wapentake of Skirbeck. It is situated in a rich agricultural district on the Witham, six miles from the sea, and thirty miles S.E. of Lincoln on the Great Northern Railway, in 52° 59' N. lat. and 0° 2' E. long.

Boston is by some supposed to have been a Roman station in the province of *Flavia Cæsariensis*, but of this sufficient evidence does not seem to exist. According to the Saxon Chronicle, St Botolph, the patron of sailors, founded a monastery at Icanhoe in 654, which was destroyed by the Danes in 870. From this Boston is said to have taken its name (Botolph's town). It became a place of considerable commercial importance after the Norman Conquest, and, in 1204, when the *quinzième* tax was imposed on the ports of England, that of Boston amounted to £780, and was exceeded only by that of London, which was £836. A great annual fair was held in the town at this period. By 27th Edward III. it was made a staple for wool, woolfells, leather, and lead. Its prosperity about this time induced merchants from the Hanseatic and other Continental commercial cities to settle here; a century later, however, these foreigners were obliged to leave, in consequence of a quarrel with the townsmen. From this time it rapidly declined. The dissolution of the monasteries by Henry VIII. injured the town, though compensation was in some degree made by granting it a charter of incorporation; and Philip and Mary endowed it with upwards of 500 acres of land. It afterwards suffered from the plague and from inundations, to which its low situation rendered it particularly liable. It was for some time the headquarters of Cromwell's army.

Arms of Boston.

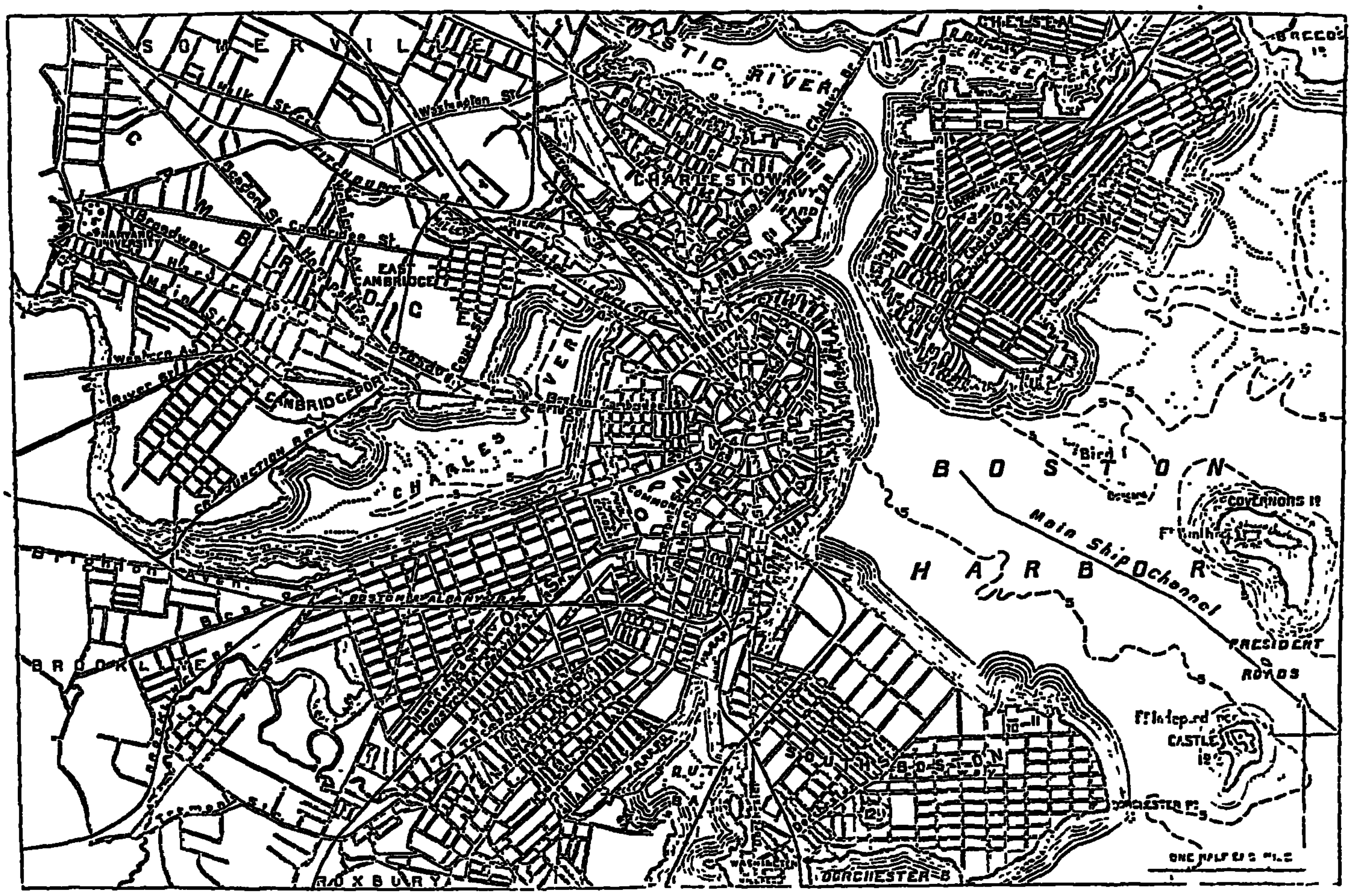
Boston is well built, paved, and lighted. It is divided into two nearly equal parts by the Witham, here crossed by an elegant iron bridge of one arch, 86 feet in span. At one time the supply of water was very deficient; but, in virtue of an Act passed in 1847, there is now a plentiful supply conveyed by pipes from a distance of twelve miles. The principal building is the parish church of St Botolph, founded in 1309, and partly restored in 1857 at the expense of the inhabitants of Boston in America, in memory of their connection with the English city. It is one of the largest churches without aisles in the kingdom, being 290 feet by 98 within the walls. The tower, 290 feet in height, resembles that of Antwerp cathedral, and is crowned by a beautiful octagonal lantern, forming a landmark seen forty miles off. A chapel of ease was erected in 1822. There is a free grammar school, founded in 1554, a charity school for the sons of poor freemen, a blue-coat, national, and other schools. There is also a dispensary, a town-hall, a market-house, a custom-house, assembly rooms, a theatre, a borough gaol, a house of correction, a union poor-house, Vauxhall gardens, a mechanics' institution, public baths, subscription libraries, an athenæum, and a freemason's hall, built in imitation of Egyptian architecture. The manufactures consist chiefly of sail-cloth, canvas, sacking, ropes, beer, leather, hats, and bricks. There are also iron and brass foundries, and ship-yards, with patent slips, where vessels of 200 tons are built.

From neglect to clear the river, it became so obstructed that in 1750 a sloop of 40 or 50 tons could with difficulty come up to the town at spring tides. Since that period great improvements have been made, and vessels of 300 tons are enabled to unload in the town. The imports are chiefly timber, pitch, tar, and hemp from the Baltic, and coal and manufactures coastwise; the exports, wool, wood, corn, and other agricultural produce. The total value of the former was in 1873, £200,825, and of the latter £86,571. By means of the river and the canals connected therewith, Boston has navigable communication with Lincoln, Gainsborough, Nottingham, and Derby. The East Lincolnshire Railway connects it with Louth, Grimsby, and other towns in the north, and the Great Northern with Peterborough and the south; another line extends to Lincoln. It has returned two members to parliament since the reign of Edward IV. The title of Baron of Boston is borne by the Irby family. In 1871 the population within the parliamentary boundaries was 18,279; within the municipality, 14,526.

BOSTON, the capital of the State of Massachusetts, in Suffolk County, and the second city in commerce, wealth, banking capital, and valuation in the United States of North America. It lies at the bottom of Massachusetts Bay, and is one of many pear-shaped peninsulas formerly attached to the mainland only by narrow marshy necks, which fringed the shores of the bay. The Charles River, once more than double its present width, divides it from the similar promontory of Charlestown (the site of the battle of Bunker Hill), on the other side of which the Mystic River, uniting with the Charles, flows into the harbour. The latest determination gives the latitude of Boston 42° 21' 27·6" N., and the longitude 5° 59' 18"E. from Washington and 71° 3' 30" W. from Greenwich. When it is noon in Boston it is 4 o'clock 44 minutes and 14 seconds at Greenwich, and 36 minutes past 11 at Washington, which is distant by railroad 450 miles.

The Indian name of the peninsula was "Shawmut," meaning "living fountains." When Governor John Winthrop, with his company, came over from England with the king's charter, to establish a government under it in the bay, they reached Charlestown, as a temporary settlement, on June 17, 1630. Looking across the Charles, the Indian Shawmut presented to the eye an elevation nearly in its centre, with three distinct summit peaks, the remnants of the only one of which now remaining constitute the present Beacon Hill, so called from its ancient use as a signal warning station. These triple summits led to the substitution of the name "Trimountaine," or "Tremont," as the English designation of the whole peninsula—a favourite title perpetuated in the name of a central street,

a hotel, a theatre, a bank, a lecture-hall, &c. A single lonely white man, the Rev. William Blaxton, a clergyman of the English Church, was then living, with house, orchard, and garden on the slope of the central hill, supposed to have come over in 1623, one of several isolated settlers on the promontories and islands of the bay, called "the old planters." He invited Winthrop's company to cross the river and build their cabins on his side, because of the purer and more abundant water-springs. On the records of the company we read, that at a court held in Charlestown, September 17 (N.S.), 1630, "It is ordered that Trimountaine shall be called Boston." This has consequently been the date assumed for the foundation of what is now the present city, and the second centennial of which was commemorated by public civic services, an oration by Josiah Quincy, a former mayor, then president of Harvard University, and a poem by the banker-poet, Charles Sprague. It is not probable that the peninsula was occupied till a month later. Blaxton, not finding the new-comers congenial associates, sold out his rights to them in 1634, and moved elsewhere. It has often been said, and has been widely accepted, that Boston received its name in compliment to the second minister of its first church, the Rev. John Cotton, formerly vicar of St Botolph's, borough of Boston, Lincolnshire, England. This was not the case. The Rev. John Wilson, of King's College, Cambridge, and of Sudbury, in Suffolk, England, came in Winthrop's company, and was first pastor of the



Ground-Plan of the City of Boston.

1. Massachusetts Hospital. 2. State House. 3. Athenæum. 4 Court-House. 5 Faneuil Hall. 6. City Hall. 7. Exchange. 8. Custom House. 9. Bunker's Hill Monument. 10. Insane Hospital. 11. House of Correction. 12. Telegraph Hill (Dorchester Heights). .... Low Water mark. - - - - - - 5 fathom line.

church. Cotton did not arrive till September 4, 1633, three years after the name Boston had been adopted. Undoubtedly the name was chosen in compliment to the much honoured Mr Isaac Johnson, one of the foremost in the enterprise, who with his wife, the Lady Arbella, daughter of the Earl of Lincoln, came with Winthrop in a vessel bearing her name. Johnson was from the English Boston, as were also his associates, Atherton Hough, who had been mayor of the borough, and Thomas Leverett, "ruling elder" of the church, who had been an alderman.

Some graceful courtesies have been exchanged in recent years between the two cities. The English Boston sent over a copy of her charter, framed in wood from St Botolph's church, and this now hangs in the city hall of the Massachusetts capital; and some descendants of John Cotton, with members of his American Church, through one of their number, Edward Everett, then American minister at the Court of St James's, united in a generous subscription to restore a chapel in St Botolph's, and to erect a monumental tablet in it to the revered teacher.

The sea-girt peninsula seems to have attracted the choice of the colonists as a place of settlement, because of its facilities for commerce and for defence. Its aboriginal occupants had previously been devasted by a plague, leaving it vacant. Some fifty years afterwards the settlers satisfied the claims of an Indian sachem, representing that his grandfather had been its proprietor. Had these settlers contemplated the enormous outlay of labour, skill, and money, which their posterity would have to expend upon the original site to make it habitable and commodious, they might have planted themselves elsewhere. There was neither wood nor meadow on the peninsula; but it might be defended from the Indians and wolves, and as one early visitor vainly imagined, from "moskitoes." The surface was very abrupt, irregular, hilly, and undulating, deeply indented by coves, and surrounded by salt-marshes left oozy by the ebbing tides, and separating the shores from the river channels. The peninsula contained less than 1000 acres, and the narrow neck, which joined it to the main, was often swept by spray and water. The

widening of Charles River near its mouth gored deeply into the northern side of the peninsula, almost dividing it, and the waters were soon turned to account for a mill-pond. This was filled up by earth from the hills in 1807, adding more than 50 acres to the territory. Another broad cove on the southern side was filled in 1837, adding 77 acres more. The Back Bay, so called, and all the flats on both sides of the original neck, have since been reclaimed for the various uses of a public garden, and squares, streets, dwellings, churches, schools, hotels, manufactories, &c., constituting, in fact, a new city with many costly and elegant structures, on what was originally the narrowest and most disagreeable, but is now the fairest and widest, portion of the primitive site. But whole forests from the State of Maine, and vast quarries of granite, and hills of country gravel, have been put to service in fringing water margins, constructing the wharves, piers, and causeways, redeeming the flats, and furnishing piling and solid foundations for the stately edifices, private houses, halls, churches, and railroad stations, principally between Charles River and the old Dorchester flats. From the first settlement, however, the ownership and occupancy of land by the citizens were not confined to the soil of the peninsula. The land needed for grazing, farming, and wood, on neighbouring promontories and islands was soon placed under the jurisdiction of Boston, for its "inlargement." Portions of territory, thus added, were from time to time severed, and have since been re-annexed. Noddle's Island, now East Boston, was "layd to Boston" in 1637. It then contained 660 acres, with several hundreds more of flats and marsh, since reclaimed. It has a wharf, 1000 feet in length, for the English and Canadian steamers. Dorchester Neck and Point, containing 560 acres, were annexed as South Boston in 1804, and the neighbouring Washington Village in 1855. The city of Roxbury was annexed in 1868; the town of Dorchester in 1870; the city of Charlestown, and the towns of Brighton and West Roxbury, in 1874. The 900 acres of the original peninsula have been doubled on its own area; while the present area of the city's jurisdiction covers 22,472 acres. The whole length of the original peninsula, from Roxbury line to Winnisimmet Ferry, was two miles and a little more than three quarters; its greatest breadth was 1 mile and 139 yards. The reclaimed territory is raised to a uniform level, sufficiently high to secure it against freshets, and is well drained. While the original site still preserves to a large extent its irregularity of surface, and its undulations, some of its former steep eminences have been reduced or wholly removed. The highest eminence in the old territory is about 110 feet above the sea-level. This work of levelling, grading, and reclaiming has been done at vast expense. But greater has been the expense of widening and straightening the narrow and crooked highways, streets, thoroughfares, and lanes of the first settlers, which are traditionally said to have been made by the cattle on their way to and from their pastures. This, next to the water-works, has been the occasion of the most considerable increase of the debt incurred by the city, somewhat relieved by assessments for betterment on abutting proprietors. It is believed that there has been a larger outlay of labour, material, and money, in reducing, levelling, and reclaiming territory, and in straightening and widening thoroughfares in Boston, than has been expended for the same purposes in all the other chief cities of the United States together. The broad watercourses around Boston are now spanned by causeways and bridges,—East Boston only, that the harbour may be opened to the navy-yard, being reached by a ferry. The first bridge over Charles River, that to Charlestown, was opened in 1786; the West Boston bridge, to Cambridge, in 1793; the Western Avenue, a solid causeway to Brookline, 7000 feet long, in 1821. Boston has now to maintain sixteen bridges. Most of the railroads also have their bridges. Six of the islands in Boston harbour are the property of the city, and three more of them have been ceded to the United States for fortifications. The harbour islands, including rocks and shoals, are very numerous, rendering the navigation through the two channels very difficult and easily guarded. But the harbour, when reached, is very secure. It is nearly 14 miles long, and 8 miles wide, giving nearly 60 square miles of anchorage. These islands were for the most part heavily wooded when first occupied, and some of them were profitably used for grazing and pasturage. Since they have been stripped of their primitive growth for fuel and building material, it has been found impracticable to reclothe them with trees, on account of the roughness of the sea-air. The washing of the soil from the bluffs of many of them, to the great injury of the harbour, has involved large expense in the erection of sea-walls. The first settlers constructed rude defences, frequently repaired and extended, on Castle Island, $2\frac{1}{4}$ miles from Boston. More formidable works were raised here by an English engineer in 1701–3. The United States Government has constructed elaborate fortifications on this site, now called Fort Independence, which, with Forts Winthrop and Warren, on neighbouring islands, offer formidable harbour defences. The first lighthouse was erected in the harbour, on Beacon Island, $8\frac{1}{4}$ miles from the town, near the Great Brewster, in 1716. This was destroyed during the Revolutionary War, re-erected in 1783, ceded to the United States in 1790, refitted in 1856 and 1860, with a tower 98 feet high, fog-horn, bell, &c., and is now called the Outer Light. An inner lighthouse was established on Long Island Head in 1819, refitted in 1855. On the long spit, at the western extremity of the Little Brewster, stands the Bug or Spit Light, erected in 1856.

It is remarkable, considering the leading and conspicuous character which has always attached to Boston from the first English settlement of the country, that it should have remained for nearly two centuries under the simple form and administration of a town government, the same as that of the smallest interior hamlets. Such a government, by all the citizens assembled in "town meeting" to dispose all their affairs, was, however, found favourable to the development and prosperity of the community. Here was trained a homogeneous population under peculiar institutions. Wealth slowly but steadily increased, through the whale and cod fisheries, the fur-trade, the sale of lumber and pitch, and a commerce largely with the West Indies and elsewhere,—though much impeded by the restrictions of the English navigation laws. Heavy exactions and drawbacks were found in the Indian and in the French colonial wars. Here began opposition to the measures of the British ministry, for oppressing and taxing the colonies. The Stamp Act, passed in 1765, was repealed in 1766. The Tea Act, passed in 1773, was defied by the emptying of three cargoes of tea into the harbour, December 16 of the same year, by a party in the guise of "Mohawk Indians." The port was closed by a British fleet, June 1, 1774. The British army evacuated Boston March 17, 1776, after having been beleaguered in it nearly a year. The constitution of the State was adopted here in 1780, midway in the war.

Boston received a city charter in 1822. Its Government is composed of a mayor, twelve aldermen, and a common council of seventy-two members, three from each of its twenty-four wards, annually elected by the citizens. There are commissioners for fire, water, health, and various other departments. There is a board of twelve overseers of the poor, with a commodious central building, connected

with twelve charitable organizations, with which the board acts in concert. The board holds charity trust funds amounting to $312,183, it expended in 1874 $101,591, and relieved 304 beneficiaries on its trust funds, and 9762 other persons.

Population, Valuation, &c.—The population of Boston, in 1708, was about 12,000; in 1719, about 18,000; in 1780, about 23,000; in 1800, 25,000; in 1850, 139,000; and, with Roxbury and Dorchester, in 1873, was 308,875. Charlestown brought with it 32,040; West Roxbury, 10,361; and Brighton, 5978. The total, in 1875, must be nearly 360,000. The valuation of the city in May 1875 was $554,200,150 of real estate, and $244,554,900 of personal property,—total, $798,755,050. The value of the corporate public property is $30,787,292. The net city debt is $27,294,208. The number of public paupers, including insane, is 689; of criminals, 1495. There are fifty-eight banks of deposit and discount in the city, the capital of which is $52,900,000, and the circulation $27,074,396. The number of savings-banks is twenty-one, with deposits of $73,322,368·56. Of fire and marine insurance companies, stock and mutual, there are thirty, with four new ones in formation, besides life insurance companies and those against accidents and for specific forms of property. The annual sale of merchandise in the city is estimated at $1,000,000,000.

Commerce.—Boston has commercial relations with every part of the globe. In 1874 the gold value of its foreign imports was $49,522,547; of its exports of foreign merchandise, $2,084,257; and of its domestic merchandise, in currency, $27,035,169. There arrived 167 American vessels from foreign ports, with a tonnage of 234,587 and 6324 men; of foreign vessels from foreign ports 1849, with a tonnage 484,448 and 18,486 men. There cleared for foreign ports, 598 American vessels, with 254,347 tons and 6606 men; and 1882 foreign vessels, with 472,941 tons and 17,995 men. The total tonnage of Boston, registered and enrolled, on December 31, 1874, was 331,266. Its commerce is slowly recovering from the effects of the war of secession.

Great Fires.—The buildings of Boston having from the first been largely of wood,—the use of which material for that purpose is now under severe restrictions,—and closely compacted, the old town suffered from frequent and disastrous conflagrations, several of which were successively described as "The Great Fire." There had been ten of these disasters, severe under the then existing circumstances, before the year 1698. In 1711, the town-house and a meeting-house, both of brick, and a hundred dwellings were destroyed. In 1760 a conflagration consumed 349 dwellings, stores, and shops, and rendered more than 1000 people homeless. But these and all subsequent ones were eclipsed in their devastation by the disaster of November 9–10, 1872, in which hundreds of costly warehouses filled with goods, with banks, offices, churches, &c., were destroyed, though all of brick or granite, involving a loss of over $80,000,000. It is an evidence of the energy and resources of the citizens, that in a little more than two years after the catastrophe, the whole "burnt district," with widened and improved thoroughfares, was covered with solid, substantial, and palatial edifices combining all the safeguards, improvements, and conveniences of modern skill. At least as large an amount has been expended on this restoration as was lost in the ruin. The fire department has been made more efficient under the control of three commissioners. There are now in the city twenty-nine steam fire-engines and a fire-boat in the harbour, eleven hook and ladder companies, sixteen horse-hose companies, a protective department, an insurance brigade, with waggons, &c., an alarm telegraph, and a system of signal boxes.

Water Supply.—Though the first white settlers were drawn to Boston by its pure and abundant springs, the want of water resources was long felt till efficient measures were taken for a supply. The southern portion of the town was supplied at the beginning of this century by an aqueduct from Jamaica Pond in Roxbury. The works already constructed and still in progress fully meet the present and prospective demands. The waters from Cochituate Lake and its tributaries, from twenty to thirty miles from the city, flowed into it by gravitation, October 25, 1848. The storage reservoirs and the works have cost up to May 1875, $10,786,739. The length of the conduit of brick is $14\frac{1}{8}$ miles, and of supply pipes of iron $262\frac{1}{8}$ miles. The annexation of Charlestown brought with it the waters of Mystic Lake, the works for which had cost $1,147,902, with $1\frac{1}{2}$ miles of brick conduit, and 127 miles of pipe, pumping engines, and reservoir.

The *public schools* of the city are organized and supervised under the statutes of the State which make provision for free education by some compulsory enactments, subject to such special regulations as may be enjoined by the Legislature. The Legislature of 1875, by an Act (chapter 241), introduced a change in the composition and functions of the school committee. Henceforward this board is to consist of twenty-four members, chosen by the citizens on general ticket, to be disposed in three sections of eight members each. After the close of the first year from the first election, eight members are to retire, and eight new members are to be elected, to serve for three years, all without compensation. The board is to elect and fix the compensation of a secretary, an auditing clerk, and other necessary subordinate officers, and also of a superintendent of schools, and a board of not more than six supervisors. The mayor is to be, *ex officio*, chairman of the general board, to which no other member of the city government can belong, and which shall have the whole management of the schools, choosing and fixing the compensation of all teachers, janitors, &c., but needing the authority of the city council before incurring an expense exceeding $1000 for the purchase of land, or the erection or alteration of a building. Boston has now 9 high schools, 49 grammar-schools, 416 primary schools, 25 evening schools and industrial, licensed minors', deaf-mute, and kindergarten schools,—total, 499. The number of teachers employed is 1289; of scholars, 53,391. Cost of maintenance for the year ending May 1, 1875, $1,724,373·61. In the old city there is a Latin, English high, girls' high, and normal school; and in each of the municipalities that have been annexed there is a high school, where classical education is furnished.

The *public buildings* of Boston are very numerous, embracing those of the United States Government, the State, the county, and the city. Most of them have been built within a few years, and are substantial and commodious, but, owing to the constant expansion and growth of the city, each of them in turn becomes contracted, and needs enlargement or a substitute. The buildings connected with each of the railroad stations have been reconstructed for extension three or four times. The largest group of edifices and works is that of the United States navy-yard, with docks, manufactories, foundries, machine shops, ordnance stores, rope-walks, furnaces, casting pits, timber sheds, ordnance parks, ship-houses, &c. The half of a very elaborate and costly edifice, the corner-stone of which was laid by President Grant, is now (1875) completed and in use for the United States post-office and sub-treasury. The other half, now in progress, will accommodate the United States courts. There is also a custom-house, with bonded warehouses, and the United States court-house.

The State House, for the business of the Legislature of the commonwealth, was built in 1798, and has been recently greatly extended. It stands on the highest land in the city,—what remains of the old *Trimountaine* summits,—and has a gilded dome, fountains, and statues on its lawn, with statues, busts, paintings, and trophies within. The edifice looks nobly down upon the "Common," so dear to the citizens of Boston. This park came with the original purchase from Mr Blaxton, and encloses 48 acres, with malls all round it, a pond, a fountain, a soldiers' monument, a deer park, and about 1300 trees. An Act of the Legislature of 1875 protects it from being encroached upon in any way by the municipal authorities without a vote of the majority of the citizens. To the State also belong a court-house and some of the newly reclaimed territory on the South Bay. To the county of Suffolk belong a jail, and court-houses, municipal and probate. The State prison is in Charlestown district.

To the city, besides the school-houses,—which bear the names of honoured citizens for many generations, and of ex-mayors,—belong a large number of structures and appliances:—the Old State House, so called, built for the British authorities in 1712,—the oldest public building now standing in the city, Christ Church, dedicated in 1723, coming next to it; Faneuil Hall, famous for its patriotic oratory, originally the gift of Peter Faneuil in 1743, used for "town meetings," and enlarged in 1806; extensive market-houses; the City Hall; the Public Library; bath-houses; engine-houses and armories; the Public Garden on the new territory, highly ornamented, enclosing more than 24 acres, with a pond; city stables, &c.

Statues in public places:—in bronze, a fine equestrian statue of Washington, and those of Dr Franklin,—born in Boston, January 17, 1706,—of Daniel Webster, Horace Mann, and Edward Everett; of marble or granite, Washington, Alexander Hamilton, Governor Andrew, Columbus, Aristides, soldiers in the war of secession, and the monument commemorating the introduction of the use of ether as an anæsthetic, first applied in the Massachusetts General Hospital, Boston.

Boston is fringed with substantial wharves on all its water margins, for the most part covered with massive warehouses. Horse railroads, or tramways, make easy connections within its own limits, and with the suburbs. Steam roads open communication with the whole continent, in every landward direction. Successive experiments have been tried with the various materials and methods for paving the streets, and constructing side-walks. The streets of the town were first named in 1708. The first map of the town, that of Bonner, was made in 1722. Overseers of the poor were first chosen in 1691. The superintendent of lamps has charge of 7664 gas, and 976 fluid, burners. The cost of gas to the city, for 1874, was $275,064·35. There are seventeen police-station houses and lock-ups; the expense of that department was $683,892·78; of the health department, $446,877·08; of the fire department, $671,511·13; of the City Hospital, $111,198·31; of penal and pauper institutions, $405,903·40. The cost of street widenings and extensions from 1822 to 1874 was $21,739,983·13; and in 1873–74, $6,403,413·76, reduced by "betterments," $283,697·50; tax assessed in 1874, $9,022,187·17 The revenue of the city was $23,633,874·06. There had been in the town and original city eleven burial-places. Mount Auburn Cemetery in Cambridge, five miles distant, enclosing 125 acres, was put to use in 1831. There have been more than 19,000 interments in it. Five other suburban cemeteries are now provided, and interments in the city are prohibited.

The Public Library, as an institution of the city, was fostered by an enterprise initiated by M. Vattemare, in securing a gift of books from the city of Paris, in 1843. Acts of the Legislature, renewed and extended from 1848 to 1857, aided by the efforts of individual citizens and meetings of committees, with free and conditional gifts of money and of books, kept the object steadily in view. In 1852 Mr Joshua Bates, born in Massachusetts, then of the firm of the Messrs Baring, of London, made a gift to the city for the purpose of a library, of $50,000, subsequently adding various donations of books. The main hall of the library building bears his name, in commemoration of his munificence. The present spacious and solid structure, which, however, already needs a second enlargement, was inaugurated for its uses, on January 1, 1858, with an address by Edward Everett. It cost, with the land, $365,000. Large donations of money and of private libraries have since accrued from living benefactors, and by bequests. The names of Ex-Mayor Bigelow, of Abbot Lawrence, and Jonathan Phillips deserve mention for their pecuniary gifts; while the libraries of Theodore Parker, Edward Everett, and George Ticknor have furnished most valuable acquisitions. Here is deposited the Prince Library, belonging to the Old South Religious Society. The unique and rich collection, known as the Barton Library, of 12,000 volumes, including the magnificent Shakspearian treasures, was obtained in 1873. The edifice has been once enlarged, with efforts to render it fireproof, and additional ground has been purchased at a cost of $70,000. The expense of its maintenance and care, in 1874, was $135,000. There are employed in it 103 persons. The number of volumes is about 280,000, besides pamphlets, MSS., and valuable collections of engravings, including the Tosti, so called. Branch libraries are established for the convenience of the citizens, in South and East Boston, Dorchester, Roxbury, Brighton, and Charlestown; and a system of other local deliveries has been initiated.

Of *churches* and places of worship in Boston, there are 163 for Protestants, 26 for Roman Catholics, and 3 Jewish synagogues. The Roman Catholics have a cathedral which will seat more than 4000. The Unitarians have the largest number of Protestant churches. There are 112 public halls, which serve very miscellaneous uses of worship, debate, lecturing, society meetings, and amusement.

Literary, learned, scientific, benevolent, and secret societies, represented by their own edifices, halls, libraries, and collections, are very numerous, and well sustained. Among these may be mentioned the American Academy of Arts and Sciences; the Massachusetts Historical Society; the Boston Athenæum, with a very extensive library, paintings, and statuary; the New England Historic Genealogical Society; the Masonic Temple; the Odd Fellows' Hall; the Mechanics' Association; the Mercantile Library Association; the Massachusetts Institute of Technology; the Boston College (Roman Catholic); the Boston University (Methodist); Young Men's Christian Union; Young Men's Christian Association, with a sectarian condition; Young Women's Christian Association; the Natural History Society; the Horticultural Society; the Marine Society; the Boston Library Society; the Music Hall, with its great organ; the Harvard Medical School, and Warren Museum; the State Library; the Law Library; the General Theological Library; the Art Museum, &c. There are four theatres in the city,—the Boston, the Globe, the Howard, and the Museum.

Hospitals, asylums, and refuges, chiefly founded and sustained by private benevolence, and generously administered, provide, for the most part gratuitously, for the various ills and maladies of humanity. Of these, besides the City Hospital, may be mentioned the Massachusetts General Hospital, with its branch for the insane, the

M'Lean Asylum, in a suburb; the Orphan Asylum; the Perkins Institution for the Blind; the Eye and Ear Infirmary; the Consumptives' Home; the Carney Hospital; the Homœopathic Hospital; the School for Idiotic and Feeble-minded; the Lying-in Hospital; the Temporary, Washingtonian, and Appleton Homes; Hospitals for Women, Children, and Infants; Homes for Aged Men, for Aged Women and for Coloured Women, for Little Wanderers; a Children's Mission; House of the Angel Guardian; Commissioners of Foreign Missions, &c. The city institutions for paupers, the insane, and criminals, are in South Boston and on Deer Island.

Ninety years after the settlement of the town of Boston, Daniel Neal, of London, wrote a description of it, returning from his visit. In this he says: "The conversation in this town is as polite as in most of the cities and towns in England, many of their merchants having travelled into Europe, and those that stay at home having the advantage of a free conversation with travellers; so that a gentleman from London would almost think himself at home at Boston, when he observes the numbers of people, their houses, their furniture, their tables, their dress, and conversation, which perhaps is as splendid and showy as that of the most considerable tradesmen in London." Though in the succession of visitors from abroad, particularly from England, who have followed Mr Neal, there have been a few who have found matter for satire and depreciatory criticism in their accounts of Boston, of its citizens, their habits, &c., the great majority of its foreign guests, especially if their own manners and errands have recommended them, have written in a similar strain. They have found there much to learn and enjoy, and to remember with pleasure. Cultivated Englishmen, particularly those who have visited Boston in recent years to obtain or to impart information, have found themselves at home there. The supposed conceit of its citizens over their own distinctive qualities or advantages has led to some pleasant banter from at home and abroad in characterizing the city as the "Athens of America" or "The Hub of the Universe."

The development, growth, and increased population of the city, under the liberal social influences, and the changes of opinion and habit, which in no part of the world are more marked and active than here, have, of course, wholly displaced the original homogeneousness of its people, and the peculiarly Puritan character of the tone and customs of life. Its large foreign population make, in traditions, habits, social relations, and religion, a nation within a nation. The unfamiliar names which appear on the signs of shops and dwellings, the relaxed usages as regards the observance of Sunday, and the indulgence in amusements, large personal freedom, &c., have made Boston, substantially, a cosmopolitan city. Those now living remember when a person who ventured to smoke a cigar or a pipe in the street would have fallen into the hands of a constable. When the traffic in the streets is annually obstructed by an elaborate procession, mounted and on foot, on "St Patrick's Day," and when a cardinal, with other officials from the court of Rome, comes hither to consecrate an archbishop in a cathedral, it is difficult to recall the virgin promontory and the English exiles with which this notice began. (G. E. E.)

BOSTON, Thomas, a popular and learned Scottish divine, born at Dunse, May 17, 1676. He was educated at Edinburgh, and in 1699 became minister of the parish of Simprin, from which he was translated in 1707 to Ettrick. It was by his recommendation that Hog of Carnock reprinted in 1718 the famous *Marrow of Modern Divinity*, which excited such a fierce controversy in the Scottish church. He also distinguished himself by being the only member of Assembly who entered a protest against the sentence passed on Professor Simson as being too slight a censure. He died May 20, 1732. His writings were numerous; but he is best known by his *Fourfold State*, the *Crook in the Lot*, and his *Body of Divinity*, works much esteemed by Presbyterians, and which long exercised a powerful influence over the minds of the Scottish peasantry. He left *Memoirs of his own Life and Times*, published in 1776. An edition of his works in 12 volumes appeared in 1849, *ff.*

BOSWELL, James, the biographer of Johnson, was born at Edinburgh on the 29th October 1740. His father was one of the lords of Session, or judges of the supreme court in Scotland, and took his title, Lord Auchinleck, from the name of his property in Ayrshire. The family was of old and honourable descent, a fact of which both father and son were not only proud but vain. James, the eldest son, was educated at Edinburgh and Glasgow Universities, and during his student days contracted a close and life-long friendship with William Johnson Temple, afterwards vicar of St Gluvias and rector of Mamhead. His unrestrained correspondence with Temple, extending with occasional breaks from 1758 to the last year of his life, affords us the best materials for a knowledge of his career and an estimate of his character. At the age of eighteen he was busily engaged in the study of the law at Edinburgh, not entirely in accordance with his own inclination, but in obedience to the desire of his father. Already, however, he had begun to take a pride in being associated with men of distinction, and tells his friend, with some exultation, that he had accompanied Sir David Dalrymple (afterward Lord Hailes) on the Northern Circuit, and had kept a journal of what was said by the great man on the way. Some other peculiarities of his character also became manifest even at this early period of his life. He was evidently unsettled and unstable, "constitutionally unfit," as he afterwards said, "for any employment;" he disliked the Scottish style of life, and longed for the elegance, refinement, and liberality of London society. In 1760 this wish was so far gratified; he tasted some of the delights of the capital, and indulged in magnificent dreams of entering the Guards and spending his time about the court. Such a fancy, however, came to nothing; for as he has narrated with some pride, the duke of Argyll told his father that "this boy must not be shot at for three and sixpence a day." A military life, indeed, would hardly have suited him, for, as he frankly confesses, his personal courage was but small.

Boswell's tastes were always literary; he had contributed some slight things to the current magazines; and in 1762 he published a rather humorous little poem, *The Cub at Newmarket*. In the following year appeared a collection of *Letters between the Hon. Andrew Erskine and James Boswell, Esq.*, which the vanity of the youthful authors induced them to think would be received with pleasure and profit by the world. The only prominent characteristic of these epistles is an overstrained attempt at liveliness and wit.

On Monday, 16th May 1763, Boswell, then on a second visit to London, had the supreme happiness to make the acquaintance of the object of his almost idolatrous admiration,—Dr Johnson. Their first interview in the back parlour of Mr Davies's shop in Russell Street was characteristic of both; the calm strength and ponderous wit of the one, the fluttering folly and childish servility of the other, are portrayed to the life in Boswell's own narrative. Few things are more singular than the intimacy which sprang up between two men so differently constituted. Boswell might indeed congratulate himself that he had something about him that interested most people at first sight in his favour. He was then about to proceed to Utrecht in order

to prosecute his studies; and the great Dr Johnson actually accompanied him to Harwich and saw him off, with many protestations of affection.

At Utrecht Boswell was as unsettled and dissipated as before. He had a fair allowance from his father—£240 a year; but he was determined "not to be straitened nor to encourage the least narrowness of disposition as to saving money." To what extent this virtuous resolution was carried out is unknown; but after leaving the university, he determined, sorely against his father's inclination, to prolong his residence abroad. He travelled through various parts of the Continent, visited Voltaire and Rousseau, and was finally attracted to Corsica, where he speedily attached himself to and became the intimate friend of the patriot Paoli. He did not return to England till 1766, but he had not neglected his note-book, and in 1768 published his *Account of Corsica, Journal of a Tour to that Island, and Memoirs of Pascal Paoli.* The book had a very considerable success, not on account of the merits of its historical or descriptive passages, but from the liveliness and truth of the journal, and from the numerous anecdotes and sayings, which brought the Corsican patriot vividly before the English imagination. Johnson's estimate of the work was discriminating and just; and other good judges, though they could not avoid noticing and ridiculing Boswell's extravagances and follies, appreciated at its true value his unrivalled power of biographical narration. The book did much for Paoli, and secured for him sympathy and assistance in England when he was compelled to fly from his native island. The author was for a time intoxicated with his success; he pestered every one with Corsica, introduced himself to Pitt in Corsican dress, and not only appeared at the Shakespeare Jubilee arrayed in the costume of an armed Corsican chief, with "Viva la Libertà" inscribed on his hat, but wrote a full description of his appearance to the *London Magazine.* He certainly gained notoriety, if not fame.

His restless spirit next found occupation in the great Douglas peerage case. He took an intense interest in this affair, acted as an unattached counsel, and published on it a novel and a pamphlet. The often repeated story, that he resented the judgment given by his father in the case to such an extent that he headed the rioters who broke the old judge's windows, is not inconsistent with his character, but as the father's judgment virtually coincided with the son's opinion, it really has no foundation in fact.

In 1769, after numerous love affairs, which are told to his friend Temple with more freedom than decency, he married Miss Montgomerie. Not much is known of this lady, except that she was a relation of the earl of Eglinton, as Boswell took care to inform the people of Scotland in his *Letter* to them in 1785. Johnson's opinion of her qualities was very low; but she probably concurred with old Lord Auchinleck in thinking the great lexicographer "a brute." She seems also to have had rather a contempt for some aspects of Mr Boswell's character, whatever that might "comprehend in his own imagination, and in that of a wonderful number of mankind."

In 1773, though against his father's will, Boswell came to London. He was admitted a member of the Literary Club, and soon after set out with his great friend on the immortal tour to the Hebrides. It was not till many years afterwards that the famous *Journal* was given to the world,—not till after the death of Johnson. Some years after the death of his father in 1782 he had joined the English bar, but he never succeeded in gaining any practice. In 1785 the *Journal of a Tour to the Hebrides* was published, and preparations set on foot for an extended *Life of Johnson.* The collection of materials and careful revision occupied several years, and though Boswell sometimes was despondent, yet on the whole he looked with well-grounded confidence for success. He was absolutely certain that his "mode of biography, which gives not only a *history* of Johnson's *visible* progress through the world, and of his publications, but a view of his mind in his letters and conversations, is the most perfect that can be conceived, and will be more of a life than any work that has ever yet appeared." His expectations were not deceived. The book, which appeared in 1791, was received with the greatest eagerness and delight; and in 1793 a second edition was published. The author's triumph and self-satisfaction were complete; but meantime the evil habits he had contracted during a dissipated life were ruining his health, both of mind and body. He was in his later years an habitual drunkard, and the hypochondria, from which he had always suffered at intervals, terribly increased. He died after a short illness on the 19th May 1795, at the age of 55.

Boswell's character is curious and somewhat contradictory. He was vain of his birth, and of his own talents, sensual and self-indulgent, inquisitive and undignified; and all these faults he parades with a perfectly childish naïveté;—not certainly without consciousness that they were faults, for he is constantly repenting of his sins and framing the best of resolutions, swearing "like an ancient Pythagorean to observe silence, to be grave and reserved though cheerful and communicative." "One great fault of mine," he says, "is talking at random. I will guard against it." But he was, as he has himself admitted, "utterly wanting in solidity and force of mind." His egotism and vanity were excessive, and he exposes these qualities with the greatest frankness to his friend Temple. "I, James Boswell, Esq.," he writes on one occasion,—"you know what vanity that name includes." And again with reference to one of his rivals in Johnsonian literature, he writes; "Hawkins is, no doubt, very malevolent; observe how he talks of me as quite unknown." The peculiar weakness of his intellect and exuberance of his spirits hurried him into absurdities and follies, and made him the butt of the society in which he moved. Yet he was far from having no redeeming qualities. He was genial and friendly, of cultured literary taste, and of no mean powers of mind. It was not a mere frivolous, foolish, prating sot who could appreciate the great qualities of Johnson, and devote himself to a friendship from which he derived no profit and little praise. And assuredly it was not by his unrivalled powers as a fool that Boswell has produced the best biography the world has yet seen. He was not only, as Macaulay admits, a man of quick observation and retentive memory, but he had also grasped with complete consciousness the true idea of biography, which he had learned from his great teacher. Johnson valued biography, because it gives us what comes home to ourselves: he thought that no one could write a real life unless he had lived in social intercourse with the man of whom he wrote, and laid it down as the duty of a biographer to give a full account of the person whose life he is writing, and to discriminate him from all other persons, by any peculiarities of character or sentiment he may happen to have. All these hints were taken hold of and assimilated by Boswell, and the result was a biography which has no equal in our own or in any other literature, which, so far from losing its popularity, is as much esteemed now as when first given to the world, and on which it seems superfluous even to bestow laudation. Johnson was undoubtedly a great man, but he would never have been to us more than a mere name had it not been for Boswell's life. Through that life he is known to us as no other English writer is; his faults and weaknesses, his grand powers of mind and rugged moral strength,—his whole personality is revived for

us. We know him as he actually lived and moved among his fellow-men. The very lights and shades thrown on his character by the narrative give it additional force, for they convince us of its intense truth and reality. Nor is it only as a life of Johnson that Boswell's book has value for us; it is the most important contribution yet made to a knowledge of actual living and thinking in the 18th century. "It is not speaking with exaggeration," says Carlyle, "but with strict measured sobriety, to say that this book of Boswell's will give us more real insight into the history of England, during those days, than twenty other books, falsely entitled 'Histories,' which take to themselves that special aim."

A short memoir of Boswell was written by Malone and will be found in Nichol's *Literary Anecdotes*. It is also reprinted, with some extracts from Boswell's letters to Malone, in the edition of the *Life* published by Bohn, 1859. The *Letters to W. J. Temple and Andrew Erskine* were printed in 1857; in the introduction will be found a pretty complete notice of Boswell's minor writings. *Boswelliana* have been published in the second volume of the Philobiblon Society Miscellanies, 1855–6, and by Dr Charles Rogers, 1874. Editions of Boswell's great work are very numerous; perhaps the amended form of Croker's first edition, by Wright (Bohn, 10 vols., 1859), is the most helpful. The famous essays on Boswell by Macaulay and Carlyle may be taken as mutually corrective and supplementary.

BOTANY

THE science of Botany includes everything relating to the Vegetable Kingdom, whether in a living or in a fossil state. Its object is not, as some have supposed, merely to name and arrange the vegetable productions of the globe. It embraces a consideration of the external forms of plants—of their anatomical structure, however minute—of the functions which they perform—of their arrangement and classification—of their distribution over the globe at the present and at former epochs—and of the uses to which they are subservient. It examines the plant in its earliest state of development, when it appears as a simple cell, and follows it through all its stages of progress until it attains maturity. It takes a comprehensive view of all the plants which cover the earth, from the minutest lichen or moss, only visible by the aid of the microscope, to the most gigantic productions of the tropics. It marks the relations which subsist between all members of the vegetable world, and traces the mode in which the most despised weeds contribute to the growth of the mighty denizens of the forest.

The plants which adorn the globe more or less in all countries must necessarily have attracted the attention of mankind from the earliest times. The science that treats of them dates back to the days of Solomon, for that wise monarch "spake of trees," from the cedar of Lebanon to the hyssop on the wall. The Chaldeans, Egyptians, and Greeks were the early cultivators of science, and Botany was not neglected, although the study of it was mixed up with crude speculations as to vegetable life, and as to the change of plants into animals. Æsculapius and his priests, the Asclepiades, who studied the art of medicine, had their attention directed to plants in a pharmaceutical point of view. About 300 years before Christ Theophrastus wrote a *History of Plants*, and described about 500 species used for the treatment of diseases. Dioscorides, a Greek writer, who appears to have flourished about the time of Nero, issued a work on Materia Medica. The elder Pliny described about a thousand plants, many of them famous for their medicinal virtues. Asiatic and Arabian writers also took up this subject. Little, however, was done in the science of botany, properly so called, until the 16th century of the Christian era, when the revival of learning dispelled the darkness which had long hung over Europe. Brunfels, a physician of Bern, has been looked upon as the restorer of the science in Europe. He published a *History of Plants*, illustrated by figures, about the beginning of the 16th century.

One of the earliest attempts at a methodical arrangement of plants was made in Florence by Andreas Cæsalpinus, a native of Arezzo, some time professor of botany at Padua, and afterwards physician to Pope Clement VIII. He is called by Linnæus *primus verus systematicus*. In his work *De Plantis*, published at Florence in 1583, he distributed the 1520 plants then known into fifteen classes—the distinguishing characters being taken from the fruit.

John Ray, a native of Essex, did much to advance the science of botany. He was born in 1628, and died in 1705. He promulgated a system which may be considered as the dawn of the "natural system" of the present day (Ray, *Methodus Plantarum*, 1682). He separated flowering from flowerless plants, and divided the former into Dicotyledons and Monocotyledons. His orders were founded on a correct idea of the affinities of plants, and he far outstripped his contemporaries in his enlightened views of arrangement.

About the year 1670 Dr Robert Morison[1] of Aberdeen published a systematic arrangement of plants. He divided them into eighteen classes, distinguishing plants according as they were woody or herbaceous, and taking into account the nature of the flowers and fruit. In 1690 Rivinus[2] promulgated a classification founded chiefly on the forms of the flowers. Tournefort[3] about the same time took up the subject of vegetable taxonomy. He was a contemporary of Ray, and was professor of botany at Paris in 1683. He was long at the head of the French school of botany, and published a systematic arrangement in 1694–1700. He described about 8000 species of plants, and distributed them into twenty-two classes, chiefly according to the form of the corolla, distinguishing herbs and under-shrubs on the one hand from trees and shrubs on the other. The system of Tournefort was for a long time adopted on the Continent, but was ultimately displaced by that of Linnæus.

Carl von Linné, or, as he is commonly called, Linnæus,[4] was born on the 23d of May 1707, at the village of Rooshoolt (Råshult), in Smaland, a province of Sweden, where his father, Nicholas Linnæus, was clergyman. He entered as a pupil at the University of Lund, and about the years 1727–28 was received into the house of Stobæus, a physician in that city, where he had abundant opportunities of prosecuting natural history. He afterwards proceeded to Upsal, and had to struggle with great difficulties during his studies there. He aided Celsius in his *Hierobotanicon*, or account of the plants of Scripture, and he became assistant to Rudbeck, professor of botany. He afterwards travelled in Lapland, took his degree in Holland, visited

[1] Morison, *Præludia Botanica*, 1672; *Plantarum Historia Universalis*, 1680.

[2] Rivinus (Augustus Quirinus) paterno nomine Bachmann, *Introductio generalis in Rem Herbariam*, Lipsiæ, 1690.

[3] Tournefort, *Élémens de Botanique*, 1694; *Institutiones Rei Herbariæ*, 1700.

[4] Linnæus, *Systema Naturæ*, 1735; *Genera Plantarum*, 1737; *Philosophia Botanica*, 1751; *Species Plantarum*, 1753

England, and commenced practice in Stockholm, where he lectured on botany and mineralogy. He finally became professor of botany at Upsal, and was one of the most popular lecturers of the day. He died on the 8th of January 1778, in the 71st year of his age. His herbarium is now in the possession of the Linnean Society.

One of his biographers, in summing up his merits, says, —"Educated in the severe school of adversity, accustomed from his earliest youth to put a high value on verbal accuracy and logical precision, endowed with a powerful understanding, and capable of undergoing immense fatigue, both of body and mind, Linnæus produced a most important revolution in botanical science. He improved the distinctions of genera and species, introduced a better nomenclature on the binomial method, and invented a new and comprehensive system founded on the stamens and pistils. His verbal accuracy and the remarkable terseness of his technical language reduced the crude matter that was stored up in the folios of his predecessors into a form which was accessible to all men. He separated with singular skill the important from the unimportant in their descriptions. He arranged their endless synonyms with a patience and a lucid order that were quite inimitable. By requiring all species to be capable of a rigorous definition, not exceeding twelve words, he purified botany from the endless varieties of the gardeners and herbalists; and by applying the same strict principles to genera, and reducing every character to its differential terms, he got rid of the cumbrous descriptions of the old writers. It is said of Linnæus, that, although no man of science ever exercised a greater sway, or had more enthusiastic admirers, yet his merit was not so much that of a discoverer as of a judicious and strenuous reformer. The knowledge which he displayed, and the value and simplicity of the improvements which he proposed, secured the universal adoption of his suggestions, and crowned him with a success altogether unparalleled in the annals of science."

The system of Linnæus is founded on the sexes of plants, and hence it is often denominated the sexual system. It is called an artificial method, because it takes into account only a few marked characters in plants, and does not propose to unite them by natural affinities. It is an index to a department of the book of nature, and as such is useful to the student. It does not aspire to any higher character, and although it cannot be looked upon as a scientific and natural arrangement, still it has a certain facility of application which commends it to the tyro. In using it, however, let it ever be remembered, that it will not of itself give the student any view of the true relations of plants as regards structure and properties, and that by leading to the discovery of the name of a plant, it is only a stepping-stone to the natural system. Linnæus himself claimed nothing higher for it. He says—"Methodi Naturalis fragmenta studiose inquirenda sunt. Primum et ultimum hoc in botanicis desideratum est. Natura non facit saltus. Plantæ omnes utrinque affinitatem monstrant, uti territorium in mappa geographica." Accordingly, besides his artificial index, he also promulgated fragments of a natural method of arrangement.

The Linnean system was strongly supported by Sir James Edward Smith, who adopted it in his *English Flora*, and who also became possessor of the Linnean collection. The system was for a long time the only one taught in the schools of Britain, even after it had been discarded by those in France and in other Continental countries.

The foundation of Botanic Gardens during the 16th and 17th centuries did much in the way of advancing botany. They were at first appropriated chiefly to the cultivation of medicinal plants. This was especially the case at universities, where medical schools existed. The first Botanic Garden was established at Padua in 1545, and was followed by that of Pisa. The garden at Leyden dates from 1577, that at Leipsic from 1579. Gardens also early existed at Florence and Bologna. The Montpellier Garden was founded in 1592, that of Giessen in 1605, of Strasburg in 1620, of Altorf in 1625, and of Jena in 1629. The Jardin des Plantes at Paris was established in 1626, and the Upsal Garden in 1627. The Botanic Garden at Oxford was founded in 1632. The garden at Edinburgh was founded by Sir Andrew Balfour and Sir Robert Sibbald in 1670, and, under the name of the Physic Garden, was placed under the superintendence of James Sutherland, afterwards professor of botany in the university. The park and garden at Kew date from about 1730. The garden of the Royal Dublin Society at Glasnevin was opened about 1796; that of Trinity College, Dublin, in 1807; and that of Glasgow in 1818. The Madrid Garden dates from 1763, and that of Coimbra from 1773. Gesner states that at the end of the 18th century there were 1600 Botanic Gardens in Europe.

A new era dawned on botanical classification when Antoine Laurent de Jussieu appeared. He was born at Lyons in 1748, and was educated at Paris under the care of his uncle, Bernard de Jussieu. At an early age he became botanical demonstrator in the Jardin des Plantes, and was thus led to devote his time to the science of botany. Being called upon to arrange the plants in the garden, he necessarily had to consider the best method of doing so, and adopted a system founded in a certain degree on that of Ray, in which he embraced all the discoveries in organography, adopted the simplicity of the Linnean definitions, and displayed the natural affinities of plants. His *Genera Plantarum*, begun in 1778, and finally published in 1789, indicated an important advance in the principle of classification. Jussieu subsequently became professor of rural botany; he died in 1836 at the age of 88.

The system of Jussieu made its way slowly in Great Britain, and it was not until Robert Brown brought it under notice that it was adopted.[1] It is now the basis of all natural classifications. One of the early supporters of this natural method was Augustin Pyrame De Candolle, who was born in 1778, and who, after attending the lectures of Vaucher at Geneva, devoted himself to botanical pursuits. He subsequently prosecuted his studies at Paris, and lectured on botany at the College of France. He commenced his publications in 1802, and in 1804 he promulgated his *Elementary Principles of Botany*. In 1807 he became professor of botany at Montpellier, and in 1816 he was appointed to the chair of natural history at Geneva, with the charge of the Botanic Garden. In that city he carried on his future botanical labours, and began his *Prodromus Systematis Naturalis Regni Vegetabilis*, which was intended to embrace an arrangement and description of all known plants. He was enabled to complete eight volumes of the work before his death, and it has since been carried on by his son Alphonse De Candolle, with the aid of other eminent botanists. It now embraces descriptions of the genera and species of Dicotyledonous plants. The system followed by De Candolle is a modification of that of Jussieu, and it is adopted more or less at the present day. De Candolle's own herbarium was extremely rich. He had visited and carefully examined many of the most extensive collections, especially those of Paris; and many entire collections, as well as separate families, on which he was specially engaged, were from time to time submitted to his examination by their possessors. He had thus

[1] Brown, *Prodromus Floræ Novæ Hollandiæ*, 1810.

opportunities of comparison greatly beyond what in ordinary circumstances fall to the lot of an individual. His library, too, was stored with almost every important publication that could be required for his undertaking. With such ample materials, aided by his untiring zeal and the persevering energy of his character, he steadily pursued his allotted task, and only ceased to labour at it when he ceased to live. For some years his health declined, and it is to be feared that the severe and incessant attention which he paid to the elaboration of the great family of Compositæ had made a deep inroad upon it. As a relaxation from his labours he undertook in the last years of his life a long journey, and attended the scientific meeting held at Turin; but he did not derive from this the anticipated improvement in his health, which gradually failed until his death on the 9th September 1841. Since De Candolle's time various modifications of his system have been introduced by Endlicher, Lindley, Hooker, and Bentham.

In arranging plants according to a natural method, we require to have a thorough knowledge of structural and morphological botany, and hence we find that the advances made in these departments have materially aided the efforts of systematic botanists.

Robert Brown, a Scottish botanist, was the first in this country to support and advocate the natural system of classification. The publication of his *Prodromus Floræ Novæ Hollandiæ*, according to the natural method, led the way to the adoption of that method in the universities and schools of Britain. Sir William (then Dr) Hooker, in his prelections in the University of Glasgow, and in his numerous writings, ably supported Brown. John Lindley also came into the field, and in 1830 published the first edition of his *Introduction to the Natural System*. Dr Robert Kaye Greville and Dr Walker Arnott were able coadjutors, more especially in the department of Cryptogamic Botany. From the year 1832 up to 1859 great advances were made in systematic botany, both in Britain and on the continent of Europe. Endlicher's *Enchiridion* and *Genera Plantarum*, De Candolle's *Prodromus*, and Lindley's *Vegetable Kingdom* became the guides in systematic botany, according to the natural system.

The following remarks embrace the views of Mr Bentham on the change from the Linnean to the natural system of classification:—"The change from the technical to the scientific study of plants was now complete. The Linnean platform, established on the relation of genera and species, had now been so long and so universally adopted as the basis or starting point, that the credit due to its founder was almost forgotten, and it was superseded by the Jussieun method, although it was chiefly by the consistent following out the principles laid down by Linnæus himself that the change had been effected. Plants were now grouped upon a philosophical study of their affinities, whether morphological, structural, or physiological."

In all classification it is necessary to define what is meant by species. The usual definition of the term has been that a species (as regards the present epoch of the earth's history) is an assemblage of individuals having characters in common, and coming from an original stock or protoplast, and their seeds producing similar individuals. It was also supposed that variation in species was restrained within certain limits, and that varieties had a tendency to revert to the parent form. The view, however, adopted by many now-a-days is, that the tendency to variation is continuous, and that, after a lapse of long periods of time, and under the influence of varying external conditions, the descendants from a common stock may exhibit the differences which characterize distinct species. These are the views which are advanced by Darwin, and which imply a complete revolution in our idea of species. This theory is thus stated by Bentham:—

1. That although the whole of the numerous offspring of an individual plant resemble their parent in all main points, there are slight *individual* differences.
2. That among the few who survive for further propagation, the great majority, under ordinary circumstances, are those which most resemble their parent, and thus the *Species* is continued without material variation.
3. That there are, however, occasions when certain individuals, with slightly diverging characters, may survive and reproduce races, in which these divergencies are continued even with increased intensity, thus producing *Varieties*.
4. That in the course of an indefinite number of generations circumstances may induce such an increase in this divergency, that some of these new races will no longer readily propagate with each other, and the varieties become *New Species*, more and more marked as the unaltered or less altered races, descendants of the common parent, have become extinct.
5. That these species have in their turn become the parents of groups of species, that is *Genera*, *Orders*, &c., of a higher and higher grade, according to the remoteness of the common parent, and more or less marked, according to the extinction or preservation of unaltered primary, or less altered intermediate, forms.

As there is thus no difference but in degree between a variety and a species, between a species and a genus, between a genus and order, all disputes as to the precise grade to which a group really belongs are vain. It is left in a great measure to the judgment of the systematist, with reference as much to the use to be made of his method as to the actual state of things, how far he should go in dividing and subdividing, and to which of the grades of division and subdivision he shall give the names of Orders, Sub-orders, Tribes, Genera, Subgenera, Sections, Species, Sub-species, Varieties, &c., with the consequent nomenclature.

Such a systematic arrangement is founded on a hypothesis which, so far as the present flora of the globe is concerned, cannot be demonstrated. Conjecture is hazarded as to the present epoch of the earth's history, by extending back to unlimited ages. If the theory is consistent with what we see around us, and is founded on plausible grounds, then we must think that we have ascertained the plan followed by the great Creator, Designer, and Upholder of all things, that we have been able to ascertain and follow His workings, and the mode in which He has created the diverse plants which have covered our globe in time and space. This new phase of systematic botany, however, requires more definite data to lead to its adoption as an explanation of the plan of creation.

The Physiology of plants did not keep pace with the advance in Classification. Grew and Malpighi were the earliest discoverers in this department of botany. Hales also contributed to it by his observations on the motion of fluids in plants. The subject of fertilization was one which early excited attention.

The idea of the existence of separate sexes in plants was entertained in early times, long before separate male and female organs had been demonstrated. The production of Dates in Egypt, by bringing two kinds of flowers into contact, proves that in very remote periods some notions were entertained on the subject. Female Date Palms only were cultivated, and wild ones were brought from the desert in order to fertilize them. Herodotus informs us that the Babylonians knew of old that there were male and female Date-trees, and that the female required the concurrence of the male to become fertile. This fact was also known to the Egyptians, the Phœnicians, and other nations of Asia and Africa. The Babylonians suspended male clusters from wild Dates over the females; but they seem to have supposed that the fertility thus produced depended on the presence of small flies among

the wild flowers, which, by entering the female flowers, caused them to set and ripen. The process was called palmification. Theophrastus, who succeeded Aristotle in his school in the 114th Olympiad, frequently mentions the sexes of plants, but he does not appear to have determined the organs of reproduction. Pliny, who flourished under Vespasian, speaks particularly of a male and female Palm, but his statements were not founded on any real knowledge of the organs. From Theophrastus down to Cæsalpinus, who died at Rome in 1603, there does not appear to have been any attention paid to the reproductive organs of plants. Cæsalpinus had his attention directed to the subject, and he speaks of a halitus or emanation from the male plants causing fertility in the female.

Grew seems to have been the first to describe, in a paper on the *Anatomy of Plants*, read before the Royal Society in November 1676, the functions of the stamens and pistils. Up to this period all was vague conjecture. Grew speaks of the *attire*, or the stamens, as being the male parts, and refers to conversations with Sir Thomas Millington, Savilian professor at Oxford, to whom the credit of the sexual theory seems really to belong. Grew says that, "when the attire or apices break or open, the globules or dust falls down on the seedcase or uterus, and touches it with a prolific virtue." Ray adopted Grew's views, and states various arguments to prove their correctness in the preface to his work on European plants, published in 1694. In 1694 Camerarius, professor of botany and medicine at Tübingen, published a letter on the sexes of plants, in which he refers to the stamens and pistils as the organs of reproduction, and states the difficulties he had encountered in determining the organs of Cryptogamic plants. In 1703 Samuel Morland, in a paper read before the Royal Society, stated that the farina (pollen) is a congeries of seminal plants, one of which must be conveyed into every ovum or seed before it can become prolific. In this remarkable statement he seems to anticipate in part the discoveries afterwards made as to pollen tubes, and more particularly the peculiar views promulgated by Schleiden. In 1711 Geoffroy, in a memoir presented to the Royal Academy at Paris, supported the views of Grew and others as to the sexes of plants. He states that the germ is never to be seen in the seed till the apices (anthers) shed their dust; and that if the stamina be cut out before the apices open, the seed will either not ripen, or be barren if it ripens. He mentions two experiments made by him to prove this—one by cutting off the staminal flowers in Maize, and the other by rearing the female plant of Mercurialis apart from the male. In these instances most of the flowers were abortive, but a few were fertile, which he attributes to the dust of the apices having been wafted by the wind from other plants.

Linnæus was the next botanical author who took up the subject, and by his sexual system he may be said to have opened a new era in the history of botany. He first published his views in 1736, and he thus writes—"Antheras et stigmata constituere sexum plantarum, a palmicolis, Millingtono, Grewio, Rayo, Camerario, Godofredo, Morlando, Vaillantio, Blairio, Jussievio, Bradleyo, Royeno, Logano, &c., detectum, descriptum, et pro infallibili assumptum; nec ullum, apertis oculis considerantem cujuscunque plantæ flores, latere potest." He divided plants into sexual and asexual, the former being Phanerogamous or flowering, and the latter Cryptogamous or flowerless. In the latter division of plants he could not detect stamens and pistils, and he did not investigate the mode in which their germs were produced. He was no physiologist, and did not promulgate any views as to the embryogenic process. His followers were chiefly engaged in the arrangement and classification of plants, and while descriptive botany made great advances the physiological department of the science was neglected. His views were not, however, adopted at once by all, for we find Alston stating arguments against them in his *Dissertation on the Sexes of Plants*. Alston's observations were founded on what occurred in certain unisexual plants, such as Mercurialis, Spinach, Hemp, Hop, and Bryony. The conclusions at which he arrives are those of Pontedera, that the pollen is not in all flowering plants necessary for impregnation, for that fertile seeds can be produced without its influence. He supports parthenogenesis in some plants. Soon after the promulgation of Linnæus's method of classification, the attention of botanists was directed to the study of Cryptogamic plants, and the valuable work of Hedwig on the reproductive organs of Mosses made its appearance in 1782. He was one of the first to point out the existence of certain cellular bodies in these plants which appeared to perform the functions of reproductive organs, and to them the name of *antheridia* and *pistillidia* were given. This opened up a new field of research, and led the way in the study of Cryptogamic reproduction, which has since been much advanced by the labours of numerous botanical inquirers. The interesting observations of Morland, already quoted, seem to have been neglected, and no one attempted to follow in the path which he had pointed out. Botanists were for a long time content to know that the scattering of the pollen from the anther, and its application to the stigma, were necessary for the production of perfect seed, but the stages of the process of fertilization remained unexplored. The matter seemed involved in mystery, and no one attempted to raise the veil which hung over the subject of embryogeny. The general view was, that the embryo originated in the ovule, which was in some obscure manner fertilized by the pollen.

In 1815 Treviranus roused the attention of botanists to the development of the embryo, but although he made valuable researches, he did not add much in the way of new information. In 1823 Amici discovered the existence of pollen tubes, and he was followed by Brongniart and Brown. The latter traced the tubes as far as the nucleus of the ovule. These important discoveries mark a new epoch in embryology, and may be said to be the foundation of the views now entertained by physiologists, which have been materially aided by the subsequent elucidation of the process of cytogenesis, or cell-development, by Schleiden, Schwann, Mohl, and others. The whole subject has been investigated recently with great assiduity and zeal by physiologists, as regards both Cryptogamous and Phanerogamous plants. The formation of germinal vesicles in the ovule, and the development of the embryo in flowering plants, have been fully considered by Griffith, Schleiden, Mirbel, Spach, Meyen, Schacht, Mohl, Unger, Naudin, Radlkofer, and others; the embryogenic process in Coniferous plants and in the higher Cryptogams by Hofmeister, Henfrey, Suminski, Mettenius, Strasburger, Eichler, Baillon, Cohn, Pringsheim, Millardet; and that of the lower Cryptogams by Thuret, Bornet, Decaisne, and Tulasne. The observations of Darwin as to the fertilization of Orchids, Primula, Linum, and Lythrum, and the part which insects take in this function, have opened up a new era in Physiological Botany. He has been followed by Hermann Müller. Darwin's experiments in reference to the movements of climbing and twining plants, and of leaves in insectivorous plants, have opened up a wide field of inquiry which he has cultivated with eminent success and with most important results. Among other authors who have contributed to the advance of Vegetable Physiology may be named Hoffmann, Sachs, Van Tieghem, Prillieux, Deherain, and Famintzen. We have thus been enabled to come to certain general conclusions on this obscure subject, and

future observers have been directed in the proper path of investigation.

In the Physiological department of botany the most important researches have been made by French and German botanists. The laboratories in connection with schools in Germany offer facilities for study which do not exist to the same extent in Britain. Physiological researches demand not only a Botanic Garden with its appendages, but apparatus of various kinds, means of prosecuting histological and chemical investigations, physical experiments, and observations by the spectroscope. Our schools require then not only lecture-rooms, but laboratories well fitted up with all needful appliances, and salaried assistants to aid the teachers in their demonstrations and the pupils in their practical work.

The department of Geographical Botany has made rapid advance by means of the various scientific expeditions which have been sent to all quarters of the globe; and the question of the mode in which the floras of islands and of continents have been formed has given rise to important speculations by such eminent botanical travellers as Darwin and Hooker. The latter has published a valuable paper on insular floras. Under this department the connection between climate and vegetation has been carefully studied both by botanists and by meteorologists. Among the contributors to this department of botany the following authors may be noticed—Humboldt, Schouw, Meyen, Berghaus, Martius, Harvey, Hooker.

The subject of Palæontological Botany has been much advanced of late by the researches of botanists and geologists. The use of the microscope in the examination of tissues has aided much in the determination of fossil plants. The more accurate study of Organography has also been the means of correcting errors in diagnosis. The nature of the climate at different epochs of the earth's history has also been determined from the character of the flora. The works of Brongniart, Goeppert, and Schimper have advanced this department of science. Among others who have contributed valuable papers on the subject may be noticed Heer, who has made observations on the Miocene flora, especially in Arctic regions; Saporta, who has examined the Tertiary flora; Dawson and Lesquereux, who have reported on the Canadian and American fossil plants; and Williamson, who has made a careful examination of many of the coal fossils, and whose excellent drawings of structure have opened a new light on the character of many of the genera. Delineations of fossils by Witham, Lindley and Hutton, and Carruthers, have tended much to advance our knowledge of the fossil flora of Britain.

Botany may be divided into the following departments:—1. *Structural* Botany, having reference to the anatomical structure of the various parts of plants, including Vegetable Histology, or the microscopic examination of tissues; 2. *Morphological* Botany, the study of the form of plants and their organs—(these two departments are often included under the general term of Organography); 3. *Physiological* Botany, by some termed Organology, the study of the life of the entire plant and its organs, or the consideration of the functions of the living plant; 4. *Systematic* Botany, the arrangement and classification of plants; 5. *Geographical* Botany, the consideration of the mode in which plants are distributed over the different regions of the globe; 6. *Palæontological* Botany, the study of the forms and structures of the plants found in a fossil state in the various strata of which the earth is composed.

In the present article we shall confine our attention to the Structure and Morphology of Plants. The limits and classification of the Vegetable Kingdom have been partly considered under BIOLOGY (vol. iii. pp. 690–696). The Classification of Plants will be taken up *in extenso* under the heading VEGETABLE KINGDOM, and the Distribution of Plants in space and time will be treated of in separate articles.

STRUCTURAL ELEMENTS OF PLANTS.

The elementary structure which is the foundation of all vegetable tissue is the *cell*. In the young succulent bud of a growing stem each cell consists of an outer firm, elastic membrane of cellulose constituting a *cell-wall*; within this, a gelatinous soft mass of *protoplasm*, of which there may be a portion distinctly marked off as a *nucleus*; and, enclosed by the protoplasm, a cell-cavity containing a more or less watery fluid, the *cell-sap* (fig. 1). Such may be taken as the structure of a typical vegetable cell, which is thus a closed vesicle or sac with fluid or semi-fluid contents. Of these elements of the cell the protoplasm is that which is essential for its growth and development. In it are contained all the substances requisite for the formation of the cell-wall and the cell-sap; and the nucleus is merely a differentiated portion of it. From it then all the other parts of the cell are formed, and it is essential to the growth of the cell. Hence it has received the appellation of *primordial cell*; and, indeed, amongst many Algæ it exists for some time as a separate cell without any cell-wall or other part. This must be borne in mind when defining the cell as a sac or vesicle. The growth of the cell is usually, at first, uniform throughout, and it has therefore a more or less rounded form; but, according to the function which it is destined eventually to perform, one or other, or it may be all, of the parts of the cell become modified or specially developed. The cell-wall may be greatly thickened; or it may grow more in one direction than another, so as to be elongated and form protuberances; or perforations may occur; or several similar cells arranged in a longitudinal series may, by obliteration of the interposed septa, unite to form a long tube which is then called a *vessel*. The protoplasm in the process of growth may be completely absorbed; and when this occurs growth ceases, and the cell-walls form merely a framework. It may, however, remain a long time, assuming various shapes and often uniting with colouring matters. The cell-sap also may disappear or may remain, containing in solution, or as definite forms in its mass, various assimilative substances, as fat granules, oil globules, starch, mineral crystals, &c. The cell.

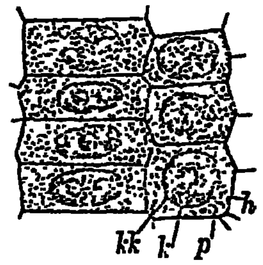


Fig. 1.

Young cells from root of *Fritillaria imperialis*. *h*, cell-wall; *p*, protoplasm; *k*, nucleus; *kk*, nucleolus. (*Sachs.*)

In some plants, as amongst Algæ (Protococcus), one cell alone performs all the functions necessary for the existence of the plant. We have thus in this cell an epitome of vegetable life, and this is the most perfect form of cell. As we pass to the higher forms of plants, where many cells are united, we find a physiological specialization taking place, by which certain cells are set apart for assimilation, some being embryonal, some supporting, and others protective, &c. Amongst such plants as Ferns and ordinary Flowering Plants a further differentiation takes place, and some of these cells unite to form true vessels. We thus have a means of arranging all plants in two groups, viz., those whose tissues consist entirely of cells, *cellular plants* (including Fungi, Algæ, Mosses, &c.); and those in which vessels are present, *vascular plants* (including Ferns, Lycopods, and ordinary Flowering Plants).

1. *Cells and Vessels—Cellular and Vascular Tissues.*

Cells united together constitute *cellular tissue* (fig. 2).

Cells and vessels. It exists in all plants and abounds in fleshy roots, stems, leaves, and in succulent fruits. It constitutes the pith and outer bark of trees, and is very abundant in the centre of the stem of the Aralia (Fatsia) papyrifera, whence Chinese rice-paper is derived by cutting it into thin sheets. By cultivation the Turnip, Carrot, Cabbage, and other esculent vegetables acquire much cellular tissue, and become tender and succulent. The cells of the tissue vary much in size. In a cubic inch of a leaf of the Carnation there are said to be upwards of three millions of cells. They are frequently seen $\frac{1}{1000}$th, $\frac{1}{500}$th, and $\frac{1}{300}$th of an inch in diameter. In some of the Cucumber tribe, and in the pith of aquatic plants, cells $\frac{1}{50}$th and $\frac{1}{30}$th of an inch in diameter occur.

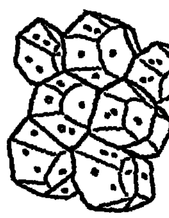
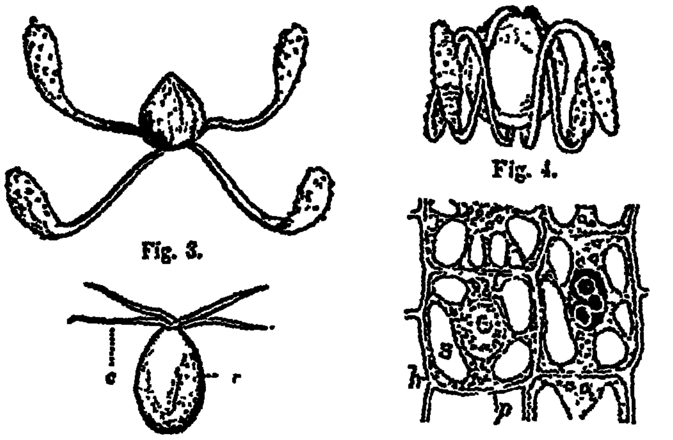


Fig. 2.
Hexagonal complete cellular tissue from the pith of the Elder.

The cell-wall. In young cells the cell-wall is a thin membrane consisting of *cellulose*, with some water and a certain amount of incombustible material. It is permeable by water, is slightly extensible and elastic, and is colourless. It dissolves in sulphuric acid, and upon addition of iodine and sulphuric acid assumes a deep blue colour. By intussusception of nutrient material, *i.e.*, the interposition of new molecules between those pre-existing, the cell-wall increases both in surface-extent and in thickness. The resulting cell-wall is not, however, uniform in its structure, but is composed of lamellæ of different refractive power, in which the cellulose is combined alternately with much and with little water. These alternating dense and watery layers,—of which one set is concentric with the cell-wall, whilst two other series are vertical or oblique to the surface of the cell-wall, and cut the concentric ones throughout the whole thickness of the wall,—under a high power of the microscope present a series of mutually intersecting lines, and constitute respectively what are termed the *stratification* and *striation* of the cell-wall.

Independently of these changes in the structure of the cell-wall, consequent on its increase in surface-extent and thickness, which will be presently noticed, there are other changes of a chemical nature which take place during the growth of the cell, and which so affect its wall as to break it into distinct "shells," which differ both chemically and physically from the original cell-wall. Thus, in the epidermis or outer cellular covering of plants, the outermost portion of the outer wall of the cells becomes converted into an elastic substance, quite impervious to water, which acts as a protective covering. This substance is known as cork or cuticular matter. Another alteration is the conversion of the layers of the cell-wall into woody matter, by a process of *lignification*, or formation of wood. Or, again, layers of the cell-wall may be converted into mucilaginous substance, *i.e.*, absorbing water, and becoming gelatinous, as in the cells of pith of Astragalus Tragacantha,—which furnishes gum tragacanth,—and the outer cells of the seed of the Common Flax. Lastly, mineral matters may be deposited in the cell-wall, such as lime, silica, &c., so abundantly in some instances as to constitute, after burning, a perfect skeleton of the cell-wall. In all these cases, however, of alteration of layers of the cell-wall, an innermost layer, giving all the reactions of pure cellulose, may be observed. If growth in surface-extent proceeded uniformly over the whole of a cell-wall the resulting structure would be a more or less rounded vesicle; but at different points portions grow more rapidly than at others, and thus cells, originally oval or spherical, may become cylindrical, conical, &c. The changes consequent on unequal growth in thickness are, however, much more important, giving rise to altered appearances both on the outside and inside of the cell-wall. The external thickenings are most usually projections in the form of spines, knobs, &c., as in some pollen-grains, and in cilia connected with the reproductive cells of many Algæ (fig. 3), or club-shaped hygrometric filaments as in Equisetum (figs. 4, 5); whilst the internal ones are more usually ridges—annular, spiral, or reticulate (figs. 11 and 12)—which may proceed so far as almost to obliterate the cavity of the cell-wall.



FIGS. 3 and 4.—Spore or reproductive cell of Equisetum, Horsetail, with two clavate hygrometric filaments. In fig. 3 the filaments are expanded in a dry state; in 4 they are curled round the spore on the application of moisture.
FIG. 5.—Cell r, with vibratile filaments or cilia c, from Chætophora.
FIG. 6.—Older cells than those represented in fig. 1. h, cell-wall; p, protoplasm with nucleus and nucleolus; s, vacuoles in the protoplasm filled with fluid cell-sap. (*Sachs.*)

The *protoplasm*, which lines the interior of the cell-wall, The protoplasm.
and which is the essential living portion of the cell, consists of albuminous substance mixed with water and some incombustible materials, and it also contains some organic compounds. It is a homogeneous, soft, gelatinous substance. As we usually find it in cells it has a granular and turbid appearance. This arises from an admixture of formative matters, to which the name *metaplasm* has been applied. It is coagulated by heat, and is soluble in a dilute solution of caustic potash; iodine solution colours it yellow or brown, whilst strong sulphuric acid at first colours it rose-red, subsequently dissolving it. Usually, at points in the interior, drops of fluid become differentiated as *vacuoli* (fig. 6), which may subsequently coalesce, and thus the protoplasm may become a sac containing cell sap; and if growth of the cell-wall continues the protoplasm eventually forms a mere lining of the cell-wall constituting the *primordial utricle* of Von Mohl. The protoplasm in some cells exhibits phenomena of movement within the cell-wall of a definite character. Thus in the internodal cells of Characeæ (fig. 7) a movement of protoplasm round the longest diameter of the cell is seen, and in the hairs of Tradescantia (Virginian Spiderwort) a circulation of protoplasm occurs. These constitute the phenomena of *rotation* and *circulation*.

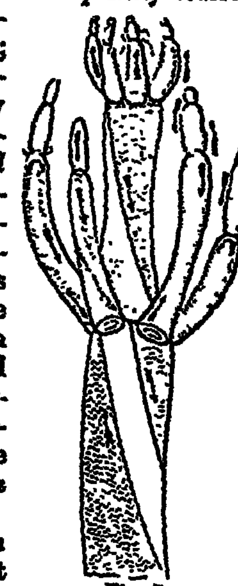


Fig. 7.
A small portion of a Chara magnified to show the intracellular circulation. The arrows mark the direction of the course of the protoplasm in the cells. The clear spaces are parts where there is no movement.

The nucleus (fig. 1, *k*) is present in the cells of all the higher plants. It The nucleus.
is a small rounded differentiated portion of the protoplasm, and frequently contains vacuoles, which are termed *nucleoli* (fig. 1, *kk*). It may be in the centre of the cell or close to the sides, but it may change its position. Portions of the protoplasm are also differentiated as grains or granules, to which colouring matters are attached; but

these will be noticed hereafter. The protoplasm in old cells may disappear, and then all growth ceases, and the cells consist of a mere framework; or it may remain, and then growth of the cell continues. And it is by a re-arrangement of the molecules of this protoplasm that the formation of new cells begins,—the nucleus entering also into the process.

By the term cell-sap is meant the fluid contained in the vacuoli. It consists in great part of water, in which are dissolved various salts, derived from without, and compounds formed by assimilation in the plant itself. Amongst the latter we may mention inulin, a substance closely allied to starch and sugar, found in Composite plants.

The term *parenchyma* (areolar, utricular, or vesicular tissue) is a general name for any form of cellular tissue, in which thin-walled cells of a diameter nearly equal in every direction are united to one another by broad surfaces (fig. 2). If the cells are pointed at both ends and have a length greatly exceeding their breadth, there is formed *prosenchyma* (fig. 8). Both tissues may be *complete* (figs. 2 and 8) or *incomplete* (figs. 9 and 10), *i.e.*, the component cells may touch each other on every side and leave no intercellular spaces, or intercellular spaces may exist between the cells. According to the amount of surface-growth and thickening of the cell-wall various forms of parenchymatous and prosenchymatous tissue result. Thus, in the Rush and Bean we have a stellate parenchyma, with large intercellular spaces (fig. 10), in the Elder pith a complete angular parenchyma (fig 2), and in the succulent stem of the Cactus a spherical incomplete parenchyma (fig. 9). Those forms of tissue in which the individual cells have been altered by thickening of the cell-wall are the most

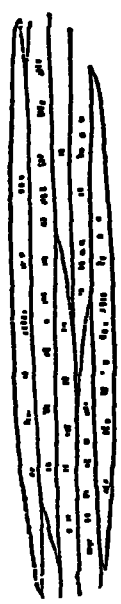


Fig. 8.

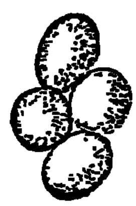


Fig. 9.

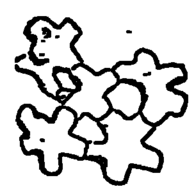


Fig. 10.

FIG. 8.—Prosenchymatous cells. FIG. 9.—Incomplete parenchyma.
FIG. 10.—Stellate or star-like cellular tissue of the Bean, with intercellular spaces or lacunæ.

important; and the alterations in the cell-wall consequent on growth in thickness may be such as to produce obliteration of the septum between superposed cells, and their cavities, freely communicating, then give rise to a tube or vessel, a combination of which constitutes the *vascular tissue* of authors. Whilst this is the nature of a true vessel, considerable confusion has arisen from the term being applied to any cell-like structure in which the longitudinal diameter exceeds the transverse; and thus the difference between a cell and a vessel became one of length only. The term vessel ought to be restricted to such as are formed by coalescence of cells.

Under the term *pleurenchyma* (fig. 8) is included tissue Pleurenchyma.
composed of such elongated prosenchymatous, flexible, thickened cells, as are found in the bast or phloëm layers of ordinary trees. They also occur in the wood portion. Their walls are thickened regularly, and they constitute when united what is commonly known as the woody or bast fibre. The diameter of the woody fibres varies from $\frac{1}{2000}$th to $\frac{1}{250}$th of an inch. The materials used for ropes and cordage, linen, certain Indian muslins, mummy-cloths, and mats consist of the woody fibre of plants from which the more delicate tissues have been removed by maceration in water. Flax or lint is thus procured from the bark of Linum usitatissimum, hemp from Cannabis sativa, New Zealand flax from Phormium tenax, Pita flax from Agave americana, Sun-hemp from Hibiscus cannabinus, and bass or bast from the common Lime or Linden-tree. Fibres are also procured for manufacture from the Pine-apple plant (Ananassa sativa), from Yucca gloriosa, from Böhmeria nivea, which yields the Indian Rheea fibre, from most of the plants belonging to the Mallow and Nettle tribes, and from some Leguminous plants, such as Crotalaria juncea, which supplies a kind of Bengal hemp. If the maceration of the fibre is carried to a great extent, a pulp is formed from which paper is manufactured. Pleurenchyma does not occur in cellular plants, such as Lichens, Sea-weeds, and Mushrooms. The tissues of these plants speedily disappear under the action of water, and hence, perhaps, the reason of their rarity in a fossil state. In the very young state woody cells are delicate, and it is only in proportion as they attain maturity that their walls acquire a thick consistence. In the sap-wood of ordinary trees the woody cells are thickened in their walls, but are pervious; while in the heart-wood they are rendered solid by the thickening matter, which is often variously coloured.

If the thickening of the cell-wall takes place so that a Spiral tissue.
network, ring, or spiral of thickening matter is formed, then the cells are *reticulated*, *annular* (fig. 11), or *spiral* (fig. 12), as in the leaves of Sphagnum, hairs of Cactaceæ, and seed-coat of Casuarina. In these cells the spiral thickening frequently becomes loosened from the cell-wall as a spiral fibre, and can be unrolled. Such forms occur in the outer covering of the seed of Collomia linearis and of the fruit of Salvia Verbenaca. In these, when placed in water, the spirals rupture the softened membrane of the cells, and spread outwards.

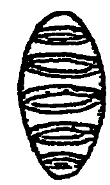


Fig. 11.

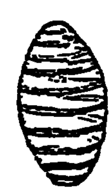


Fig 12.

FIG. 11.—Annular cell from the Mistleto.
FIG. 12.—Spiral cell from an Orchid.

The spongy elastic character of the outer cellular covering of the roots of tropical Orchids and Araceæ, of Plate X
the sepals of Illecebrum verticillatum, of the pericarp of fig. 2.
Cachrys Morisoni and C. odontalgica, and of the ribs of the fruit of Æthusa Cynapium, is due to the presence of spiral cells. In the reproductive cells of Hepaticæ spiral fibres called *elaters* are found in connection with the spores. Reticulated or netted cells, produced by fibres forming a sort of mesh or network, occur in the wing of the seed of Swietenia, in the pericarp of Picridium tingitanum and P. vulgare, in the seed-coat of Cucurbita Pepo, in the parenchyma of the leaf of Sanseviera guineensis, and in isolated cells of the pith of Rubus odoratus and of Erythrina Corallodendron.

diameter. The spiral thickened portion of the wall of the vessel may become loosened from the membrane of the wall and form a spiral fibre in the interior. These fibres are elastic, usually rounded and simple; but sometimes two or more are combined so as to form a flat band. These flat ribands, consisting of fibres which vary in number from two to twenty-five, or more, are met with abundantly in the stems of Bananas and Plantains, and in the shoots of Asparagus. The spiral in such cases is called compound, and the vessels *pleiotracheæ*. The spiral fibres have such tenacity that when the vessels are ruptured they can be pulled out. This capability of being unrolled characterizes true spiral vessels (fig. 13). When the spiral is not loosened from the cell-wall and cannot therefore be unrolled, it is said to be *closed*. On breaking the young shoots or leaf-stalks of the Geranium, Strawberry, and Rose, or the leaves of the Hyacinth, Amaryllis, and Banana, and pulling the parts gently asunder, the fibres can be easily seen in the form of a fine cobweb. When the aerial stems of the Banana and Plantain are cut across, the spiral fibres may be pulled out in large quantity so as to be used for tinder. Generally, the coils or volutions of the fibre are said to be left-handed, that is, turning to the left of a person supposed to be in the axis. In the

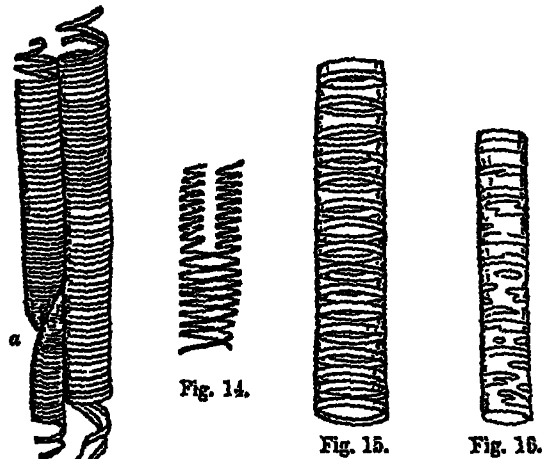


Fig. 13. Fig. 14. Fig. 15. Fig. 16.

FIG. 13.—Spiral vessels of the Melon, showing the elastic fibres uncoiled, and the vessels overlapping at their pointed extremities *a*
FIG. 14.—Branching fibre, from spiral vessels of Gourd (*Cucurbita Pepo*).
FIG. 15.—An annular vessel taken from the Melon plant.
FIG. 16.—Reticulated vessel taken from the Melon plant.

garden Lettuce vessels are met with, some having the fibre turning to the left, others to the right. In the Scarlet Bean the coils of the fibres are left-handed, while the plant itself turns to the right in twining. Spiral vessels are abundant in young plants and shoots, while in the hard stems of trees and shrubs they chiefly surround the pith. Spiral vessels occasionally exhibit a branched appearance. This may arise from the union of separate vessels, or it may depend on a regular division of the fibres, as is seen in the Mistleto, House-leek, and Gourd (fig. 14). *Annular* vessels are those in which the thickening (or, if it be loosened from the wall of the vessel, the fibre) is in the form of rings (fig. 15). These rings in Mammillaria quadrispina, and in some other plants of the Cactus tribe, are very thick, and leave only a small canal in the centre of the vessel. Annular vessels are from $\frac{1}{300}$th to $\frac{1}{100}$th of an inch in diameter. In *reticulated* vessels (fig. 16) the thickenings take the form of a network. All vessels of this type lose very early their protoplasmic contents, and serve to convey air.

Bordered pits. In the process of thickening of the cell-wall, if large spaces of the cell-wall remain thin, and the thickening mass growing in a circular manner projects into the interior of the cell and gradually arches over the thin portion of cell-wall, a dome-shaped cavity is enclosed betwixt the thin cell-wall and the thickening mass. The growing thickening mass gradually contracts the opening into this cavity, but never completely closes it. On front view this presents the appearance of two concentric circles, an outer marking the edge of the original thin portion of the cell-wall, and an inner indicating the under edge of the gradually contracting ring of thickening matter (fig. 17). When this process takes place on opposite sides of the partition wall between two cells, there are then two similar cavities separated by the thin partition wall of the cells, each communicating freely by a small circular aperture with the cell in which it has been formed (figs. 17 and 18). In process

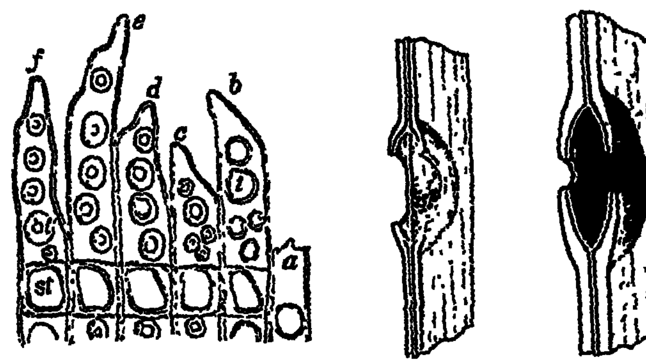


Fig. 17. Fig. 18. Fig. 19.

FIG. 17.—Radial longitudinal section of wood of *Pinus sylvestris*. *a*, cambium: *b*, *c*, *d*, *e*, *f*, wood cells; *t*, bordered pits in an early stage of formation, before the thickening ring has arched over the thin portion of cell-wall; *t'*, bordered pit after the thickening mass has arched over the thin cell-wall; *st*, very large pits where in contact with medullary rays.
FIG. 18.—Diagram to show thickening dome on both sides of the partition wall.
FIG. 19.—Partition wall has given way and a single cavity is formed, communicating on both sides with adjacent cells. (*These figures after Sachs.*)

of growth the partition wall is absorbed, and then a lenticular cavity is formed, connected by a circular aperture on each side with adjacent cells (fig. 19). When viewed by transmitted light these present the appearance seen in fig. 17 *t'*; such structures are termed *bordered pits*, and a collection of such cells constitutes the *disk-bearing or punctated tissue* of authors. It is well seen in Firs and other cone-bearing plants. It has been called *glandular* tissue. In the case of some fossil woods, pieces of silica, like double convex lenses, have been found in the cavities. When a vertical radial section is made of the stem of Fir, bordered pits, arranged in two rows, with individual pits on the same level, are seen. In Araucaria double and triple alternating rows are seen; whilst in the Yew a prominent striation line winding spirally amongst the pits is noticeable. When the thickening begins by the formation of transverse ridges extending right across the wall of the cell, and the inwardly projected ridges gradually arch over the thin membranous portion of the wall, a narrow fissure only is left leading into the cavity enclosed by the thickening masses and the thin portion of the partition wall, on the opposite side of which a similar process has proceeded. By the absorption of the partition wall a single cavity between two cells is thus produced, communicating with both, just as in the last case. Viewed by transmitted light these present an appearance like rungs of a ladder, and hence the name *scalariform* applied to the cells in which they occur (fig. 20). They are specially seen in Ferns, where they give rise to long prismatic vessels.

Fig. 20.

Scalariform or ladder-like prismatic vessels of a Tree Fern.

Pitted tissues. When the thickening takes place over nearly the whole of the cell-wall, thin portions may be left here and there, which appear as pits when viewed by transmitted light,

or as small canals when the cell-wall is very thick. Such cells are termed *porous* or *pitted* or *dotted* cells (fig. 21). In old cells, after the protoplasm has disappeared, the portion of the cell-wall which remained thin is often absorbed, and thus there is a true perforation of the cell-wall. These perforations often occur in groups both upon the cell-wall and upon the septum between superposed cells, and give rise to a remarkable sieve-like structure, in which case they are termed *sieve-cells*. The *latticed cells* of some authors are of a similar nature. When superposed porous or sieve-cells coalesce by complete obliteration of the septum, then a *pitted vessel*, *sieve tube*, or *duct* is formed (fig. 22). These ducts are usually of a larger size than other vessels; they are well seen in the inner phloëm layers and in the wood of trees, and they constitute the large rounded openings which are seen in the transverse section of the stems of the Oak, Poplar, Willow, &c. They also abound in the Bamboo (fig. 23), and in other plants of rapid growth. The names of *bothrenchyma* and *taphrenchyma* have been given to a tissue composed of such cells. Not unfrequently contractions are visible on the outside of the vessel (fig. 22), indicating its formation by coalescence of superposed cells. To vessels exhibiting contractions of this kind, whether spiral or pitted, the terms *moniliform* and *vermiform* have been applied; and the tissue composed of these moniliform vessels has been denominated *phleboidal*. In the ducts of many plants a remarkable appearance is produced by the protrusion, through the perforations into the cavity of the vessel, of portions of the adjoining cells, or, before its absorption, of the portion of partition-wall closing the pit. These portions appear as cells filling the interior of the vessel, and are described under the name of *tylosis* (fig. 24). It is well seen in the Walnut, Chestnut, Oak, &c.

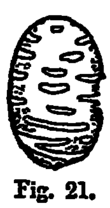


Fig. 21.

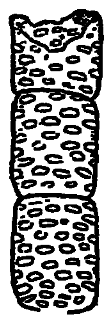


Fig. 22.

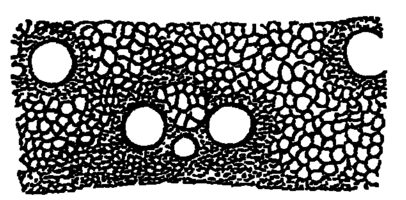


Fig. 23.

FIG. 21.—Porous or pitted cell from the Mistleto.
FIG. 22.—Moniliform dotted or pitted vessel from the Melon.
FIG. 23.—Section of a Bamboo, showing an angular network of cells, and the round apertures of pitted vessels.

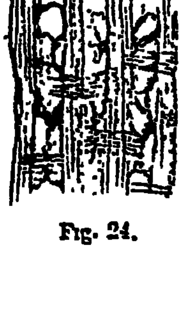


Fig. 24.

Fig. 25.

FIG. 24.—Longitudinal section of the stem of a species of Walnut (*Juglans cinerea*), showing tylosis in pitted vessels, *a*.
FIG. 25.—Branching and anastomosing laticiferous vessels. The arrows make the direction of the current.

Laticiferous vessels. *Laticiferous* vessels (fig 25) consist of long branching tubes or passages, having a diameter of about $\frac{1}{1100}$th of an inch, forming, by their union, an anastomosis or network, like the veins of animals. They are the *milk* vessels and the *proper* vessels of old authors. They receive their name from containing an emulsion called *latex*, of a granular nature, often milky or coloured. They are seen in the India-rubber and Gutta-percha plants, the Mudar plant, the Cow-tree, Spurges, Dandelion, Lettuce, Chicory, and Celandine, frequently containing a large quantity of caoutchouc. Usually these vessels are thin-walled, but sometimes slightly thickened. They are found most abundantly in the phloëm layers—rarely in the xylem or wood layers (Papayaceæ). They are the result of the coalescence of anastomosing or rectilinear rows of cells, and sometimes they seem to have resulted from the conversion of other vessels. In some Araceæ they seem to represent spiral vessels. In Asclepiadaceæ they are evidently bast-fibres. Some consider them as merely intercellular canals. The milky sap of Euphorbia phosphorea is said to be luminous. The latex exhibits movements which have given origin to the name *cinenchyma* applied to laticiferous tissue by some authors. Those movements, classed under the name *cyclosis*, must not be confounded with the motion of protoplasm in cells which is designated rotation.

We have seen that the cellular tissue is sometimes incomplete, that is, the cells do not touch on every side (fig. 9). The intervening spaces are called *intercellular spaces*, and these may be either circumscribed cavities called *lacunæ*, or they may extend for some length through the tissue as *intercellular canals*; but these two structures pass into one another. In the earliest stage of development the tissue is always complete, and these spaces are formed subsequently by a splitting of the partition or common wall of the cells, and they may subsequently be increased in size by an absorption of the investing cells. These lacunæ and canals may contain air, especially in aquatic plants, to give them buoyancy, as in Potamogeton (fig. 26), or they may be receptacles for various secretions, and when they exist as canals they usually aid in conducting sap. The intercellular canals are exceedingly well seen in coniferous plants, where they constitute resin passages, forming a continuous system throughout the plant, and arranged at intervals in concentric circles in the xylem or wood portion of the stem. Intercellular spaces.

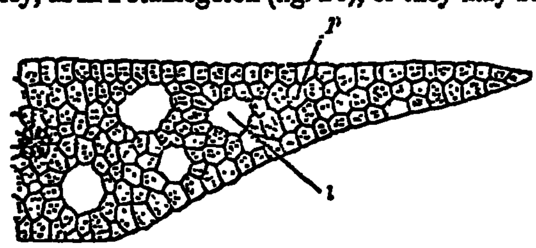


Fig. 26.

Vertical section of the leaf of Potamogeton or Pondweed, showing air cavities or lacunæ *l*, and parenchymatous cells *p*, with granules.

Chlorophyll is the green colouring-matter of plants. It occurs in the cells of the superficial parts of plants united with small portions of the protoplasm (*chlorophyll bodies*), which are combined into grains of various forms. Starch-grains are usually abundant in the chlorophyll bodies. Chlorophyll is soluble in alcohol and ether. It consists of four substances, two yellow and two green, which possess distinct optical properties. It gives a black band in the red of the spectrum. Physiologically it is very important. It is developed under the action of light, and undergoes changes according to its state of oxygenation. Hence the varied tints of leaves in autumn. Numerous colouring matters occur in plants, especially in flowers, and all such when not green are included under the general term *chromule*. Starchy and oily matters and albuminoids occur very abundantly in the cells of plants, where they are stored Substances found in cells.

Starch. for the purposes of nutrition. Starch, composed chemically of carbon and the elements of water (hydrogen and oxygen), its formula being $C_6H_{10}O_5$, occurs in the form of fine grains, more or less oval or rounded, which vary in diameter from the $\frac{1}{1000}$th to the $\frac{1}{240}$th of an inch. Each grain contains starch in two forms,—one, receiving the name *granulose*, is easily soluble, and gives a deep blue colour on the addition of iodine; the other form, *starch cellulose*, is less soluble, and gives a yellow or brown colour with iodine; but the former is most abundant in the grain. The individual grains either lie distinct from each other in the cells, as in the Potato, Wheat, and Pea, or they are aggregated so as to form compound grains, as in West Indian Arrowroot, obtained from Maranta arundinacea, and Portland Sago, procured from Arum maculatum. Grains of starch present a very characteristic concentrically striated appearance (fig. 27). This is the result of their mode of formation. The point round which the striæ are arranged is called the *hilum*. Starch is accumulated in the internal, and often in the subterranean parts of plants. It occurs abundantly in fleshy roots, and in stems, as well as in seeds and fruits, and is easily separated by washing. The ordinary cultivated grains yield starch in considerable quantity; so also do the Potato, Arrowroot, and Cassava plants, the Sago-palms, and Banana fruit. That procured from the Arrowroot plant consists of dull white grains; while that from the Potato, and from various species of Canna supplying tous-les-mois, is in the form of large shining particles. Sago and Tapioca are granulated forms of starch, the former being procured from the cells of various species of Sagus and Metroxylon, the latter from the Cassava plant. The existence of starch in the bark and young wood of trees, such as the Birch and Pine, renders them useful as articles of food in cold countries. Lichenin is a form of starch existing in the cells of Iceland moss and other lichens; while inulin, which occurs dissolved in the cell-sap, is the starchy matter supplied by the roots of the Dahlia, Dandelion, and Elecampane. By the action of prolonged heat, as well as by the addition of dilute sulphuric acid, or of malt, starch is converted into a soluble gummy substance called dextrin. The same change occurs during germination or the sprouting of the seed. Oily matters occur as drops in the interior of cells, usually associated with starchy substances or with albuminoids. These latter exist as small granules or large rounded masses with definite chemical and optical properties, and are termed *aleurone grains*. They are frequently associated with a crystalline arrangement of portions of the protoplasm of the cell known as *crystalloids*.

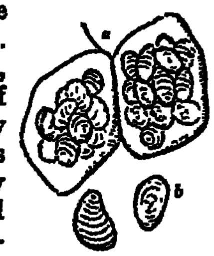


Fig. 27.

a, Starch cells of the Pea, showing grains of starch in the interior. *b*, Separate starch grains, with striæ and hilum.

Sugar. Sugar occurs abundantly in the sap of plants. When pure and in a solid state this substance is crystalline and soluble in water; but it also occurs in an uncrystallized form. There are two marked varieties of it. Cane-sugar, $C_{12}H_{22}O_{11}$, procured from the Sugar-cane, Sugar-maple, Beet, Carrot, &c.; and grape-sugar, occurring in numerous fruits, as Grapes, Gooseberries, Currants, Peaches, and Apricots The formula for grape-sugar is $C_6H_{12}O_6$. During the sprouting of the seed, starch is converted into grape-sugar, and a similar change is induced by the action of malt, or of any ferment. A sweet substance (not a true sugar), called Mannite, is procured from the Manna-ash (Ornus europæa) as well as from various sea-weeds, from species of Eucalyptus, and

Gum. from the Dandelion. Gum or mucilage is another substance found in vegetable tissues. When pure it is clear, soluble in water and also in dilute acids, but not soluble in alcohol or ether. It is one of the forms through which vegetable matter passes in being applied to the purposes of plant life. It exists largely in the vegetable juices. From the bark of many trees it is procured in the form of an exudation. Two well-marked kinds of gum are met with,—arabin, soluble in cold water, constituting the chief ingredient of gum-arabic, procured from various species of Acacia; and cerasin, insoluble in cold water, but readily soluble in boiling water, constituting the gummy secretion obtained from the Cherry and Plum. A substance called bassorin, or vegetable jelly, is found in Tragacanth, the roots of some Orchids, as well as in Carrageen (Chondrus crispus), and other sea-weeds. It is allied to gum, but differs in swelling up and becoming gelatinous when mixed with water. Another gum-like substance called pectin exists in the juice of the Apple, Pear, and other pulpy fruits. It is changed by the action of alkalies into pectic acid, which is found in many fruits and such succulent roots as Carrot, Turnip, Beet, &c. Oils, Fats, and Resins occur in Oils and resins.
cells of plants, or in special canals or glands as products of assimilation. The oils are either fixed or volatile,—the former being divided into drying, fatty, and solid, while the latter are distinguished according as they consist of carbon and hydrogen alone, or of these elements combined with oxygen or with sulphur. Resinous matter occurs in the form either of fluid balsams, or of the various kinds of solid resin and pitch. In the rind of the Orange and Lemon glands of oil occur (fig. 28). Turpentine canals are met with in the wood of Pines; and Vittæ, or oil-canals, in the fruit of Umbelliferous plants, such as the Coriander. In the fleshy covering of the fruit of the Olive there are numerous oil-cells. The fruit of the Guinea-palm yields a solid oil, called palm-oil. The dotted appearance of the leaves of the Orange, Myrtle, Eucalyptus, and St John's Wort, depends on the presence of numerous cells or cavities containing essential oil.

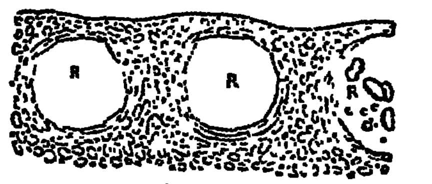


Fig. 28.

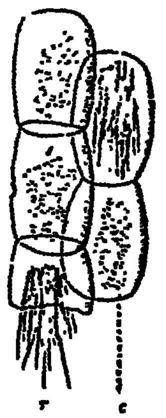


Fig. 29.

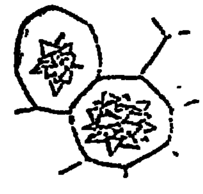


Fig. 30.

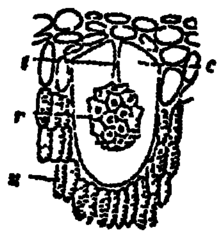


Fig. 31.

Fig. 28.—Vertical section of part of the rind of the Orange, showing glands containing volatile oil, R, R, R, surrounded by cells.
Fig. 29.—Cells of Rumex *c*, containing raphides *r*. The cells are called Raphidian. The raphides are acicular or needle-like crystals forming bundles.
Fig. 30.—Cells of Beet-root, containing conglomerate crystals.
Fig. 31.—Cellular tissue from leaf of *Urostigma (Ficus) elasticum*. *c*, a large cell, *r*, cystolith, an agglomeration of crystals situated at the extremity of an inward prolongation of the cell-wall, *t*; *x*, cells filled with chlorophyll granules.

As allied to these secretions, we may notice caoutchouc, which is found in the milky juice of plants, especially those belonging to the Fig, Spurge, and Dogbane orders. The trees most prolific in this substance are Siphonia elastica, Urceola elastica, and Urostigma elasticum. Gutta-percha is the concrete milky juice of the Taban plant (Isonandra Gutta). Wax is also found in the tissues of plants, and it frequently occurs as a secretion on the stems, as in the Wax Palm, and on the surface of fruits, as in the bloom or glaucous secretion of the Plum and the Candleberry Myrtle. Crystals of lime salts occur in the interior of cells, and also in the cell-walls of plants. They

consist of lime in combination with carbonic or oxalic acids, and are in many plants very abundant. In Monocotyledons they usually assume the form of needle-like crystals, and are termed *raphides*; they consist of oxalate of lime (fig. 29). They are remarkably well seen in the Banana. The Squill bulb and the bulb of the Onion exhibit raphidian cells, which are easily separated during the decay of the plants. The crystals are also arranged in a conglomerate form (fig. 30), as may be seen in the root of Turkey Rhubarb, to which they impart grittiness; and in Old-Man-Cactus they constitute :0 to 80 per cent. of the dried tissue. In a single cell of the Poke (Phytolacca decandra) twenty to thirty crystals may be seen. In the epidermal cells of species of Ficus, and other allied plants, prolongations inward of the cell-wall occur, at the extremity of which small crystals of carbonate of lime are deposited (fig. 31); to these the name *cystoliths* has been applied. Siliceous matter occurs in the walls of cells, as in Grasses and Horsetails, and especially in Diatomaceæ.

2. *Integumentary System.*

A more or less marked division of the tissues into an outer layer bounding an inner mass is visible in all plants. Amongst the lower cellular plants this division is not very distinct; the circumferential cells are perhaps only a little smaller and more compacted than those near the centre. The higher cellular plants, however, exhibit great diversity.

mis. In them the cells of the circumference may be arranged in layers so as to constitute a true epidermis, the component cells having a definite relation to one another and to the exterior in the respective families. In all vascular plants an epidermis is found. In many cases, however, it is difficult to recognize it, as in the stems of submerged plants and in most roots. It usually consists of a single thin layer of cells closely compacted, and leaving no interspaces except at definite points (*stomata*), where openings lead into intercellular cavities. The cells composing this layer have their outer wall much thickened, the inner wall remaining thin, and they contain no starch or granular matter, and usually are colourless. In many aquatic plants, however, and in Ferns, chlorophyll is present. The apparent colour of the epidermis depends on that of the parenchymatous cells below, from which it can be separated as a colourless layer. Sometimes the cell-sap of the epidermal cells has a red tinge. The outer lamella of the outermost cell-wall of the epidermal cells usually becomes cuticular or corky, and thus is formed an external separable layer or *cuticle* upon the surface of the *epidermis proper*. This layer has different chemical properties from the epidermis, being insoluble in sulphuric acid. Upon this cuticle wax is frequently deposited in various forms, serving as a protective from moisture; of this nature is the bloom of the Plum. The cuticle in aquatic plants is very thin; in aerial plants it is much thicker. The single layer of cells forming the epidermis is not unfrequently strengthened by the addition to the inside of other layers of cells. In the leaves of Begonia, Ficus, and the outer covering (*velamen*) of the aerial roots of Orchids, this constitutes the *hypoderma*, the cells being of various forms. It is well seen also in vascular Cryptogams, many Bromeliaceæ, Ilex, &c. On those parts of the plant which live long and have vigorous growth in thickness the efficacy of the epidermis as a protective covering is increased by a large formation of cork. Each epidermal cell divides into an outer and an inner cell. The former at once becomes a cork cell, losing all its succulent matter; the latter remains capable of division. When a layer of these merismatic cells occurs we have a *cork cambium* or *phellogen*. If several layers of cork cells be formed a *cork tissue* or *periderm* is the result, which supersedes the epidermis, and which from variations in the several layers may be stratified. Not unfrequently the phellogen cells, in addition to giving off cork cells outwardly, give rise on the inner face to cells containing chlorophyll; and if a layer of such is formed it is termed a *phelloderm*. In such cases the phellogen lies between the phelloderm and the periderm. If phellogen lamellæ are formed deeper in the tissues of the plant, the internal layers of tissue become dry and constitute the bark. Periderm is thus replaced by bark. One Stomata.
important character of the epidermis is the presence of *stomata* or breathing-pores. These exist abundantly upon the stems and leaves of plants; they also occur on the parts of the flowers; but they are absent from all root structures, though present on underground axial structures. Each consists of a central pore bounded by two or more cells (guard-cells), which contain chlorophyll, starch, and matters distinct from the surrounding epidermal cells. The pore has various forms, and opens into an intercellular cavity (fig. 32). It may be round (Primrose), oval (Liliaceæ), quadrangular (Yucca). The arrangement of the stomata on the plant varies much. They may be in lines as in Equisetum, or they may be scattered irregularly as in Balsam (fig. 33), or in definite clusters as in Crassula and Saxifraga (fig. 34). In Equisetum the stomata, which are about $\frac{1}{250}$th of an inch in their greatest diameter, consist of four guard-cells; two of which are arched and thick at their outer convex margin, becoming thin at their inner c

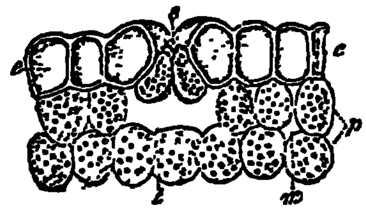


Fig. 32.

Vertical section of epidermis, from the lower surface of the leaf of Bladder, showing the intimate union of the epidermal cells *e*, *e*, the loose subjacent parenchyma *p*, with intercellular canals *m*, and lacuna *l*; *s*, stoma.

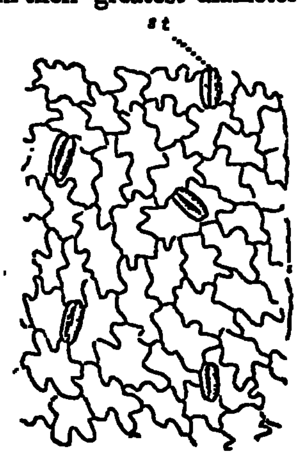


Fig. 33.

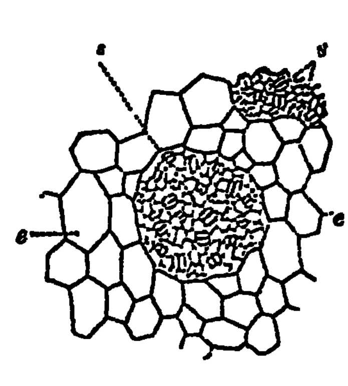


Fig. 34.

FIG. 33.—Epidermis of the garden Balsam (*Balsamina hortensis*), showing stomata *st*, of an elliptical form.
FIG. 34.—Epidermis of leaf of *Saxifraga sarmentosa*, showing clusters of stomata *s*, *s*, surrounded by large epidermal cells *e*, *e*. The cells among which the stomata occur are very small.

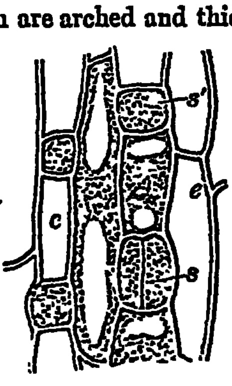


Fig. 35.

FIG. 35.—Formation of stomata from leaf *e*, epidermis cells; *s'*, mother-cell of s mother-cell into two guard-cells. (Sachs)
FIG. 36.—Splitting of partition wall be (Sachs)

smaller cells overlie them, with their upper walls raised as ridges running at right angles to the stoma. This gives the stoma a fringed appearance, hence called pectinate. The mode of formation of a stoma is an interesting process, resulting from the division of a single epidermal cell. Preparatory to the complete formation of the mother-cell of the stomatic guard-cells, divisions may take place in the epidermal cells by which numerous or few cells are formed surrounding this mother-cell. In the mother-cell a partition wall is developed (fig. 35, *s*). A thickening of the partition wall occurs, and eventually in the central portion a fissure makes its appearance, which gradually increases in size (fig. 36). It does not, however, pass throughout the whole extent of the partition wall. An opening or stoma is thus formed, bounded on each side by a single guard-cell, leading into an intercellular space in the parenchyma beneath. If we suppose the mother-cell to be divided by numerous vertical septa we should have a stoma surrounded by many guard-cells, as occurs in some Hepaticæ; and in this family, after the formation of the fissure a series of horizontal septa appear in the guard-cell, and thus the stomatic opening becomes a canal. In Ceratopteris thalictroides the stoma is bounded by three cells,—two of which, in their open condition, are crescentic and concave inwardly, while the third surrounds them, except for a small space at the end of the long axis of the stoma, and has on this account been called *peristomatic*. In Urostigma elasticum four cells form the stoma. Subsequent changes in the surrounding epidermal cells may cause alterations in their relations to the stomata. Thus, in the Oleander (fig. 37) the epidermis

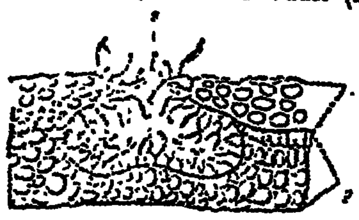


Fig. 37.

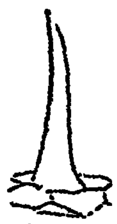


Fig. 38.

the Rice-paper plant (Fatsia papyrifera). When stellate hairs are flattened out, so as to form a sort of membranous expansion (fig. 44), a *scale* or *scurf* is produced. In Bromeliaceæ the scurfiness of the leaves is a marked character. To such expansions of the epidermis the name *lepis* is applied, and the surface is said to be *lepidote*. These scales have sometimes a beautiful silvery appearance, as in Elæagnus and Sea-buckthorn (fig. 44). Surrounding the base of the leaves of Ferns a brown chaffy substance occurs, consisting of elongated cells, to which the name of *ramentaceous hairs*, or *ramenta*, has been given. In Palms also a similar substance but of a fibrous texture occurs, called *reticulum* or *mattulla*. *Setæ* are bristles or stiff hairs, and the surfaces on which they occur are said to be *setose* or *setaceous*. Some hairs, as those of Drosera

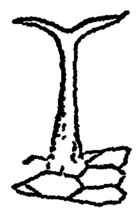


Fig. 39.

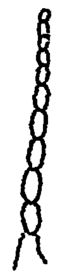


Fig. 40.

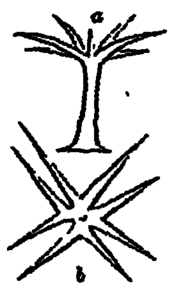


Fig. 41.

Fig. 42.

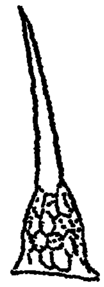


Fig. 43.

FIG 39.—Forked or bifurcated unicellular hair of Draba or Whitlow-grass.
FIG 40.—Moniliform or necklace-like hair of Virginian Spiderwort (*Tradescantia virginica*).
FIG 41.—Unicellular hair *a*, of Alyssum, dividing into rays at the apex. The stellate or star-like arrangement is represented in the lower figure *b*.
FIG 42.—Glandular, multicellular or many-celled hair of Frogsmouth (*Antirrhinum majus*). It is a partitioned capitate hair.
FIG. 43.—Sting (stimulus) of Nettle (*Urtica dioica*); its base is formed by numerous cells containing irritating fluid; from these arises a simple unicellular conical hair, which serves as a duct for conveying the fluid.

(Sundew), have one or more spiral fibres in their interior. When the cells of hairs are hardened by thickening of the cell-wall, as in the Rose and Bramble, they are called Prickles (*aculei*). By some these are not considered as hairs, but are termed *emergencies*, inasmuch as they arise from a collection of cells, not from one epidermal cell. Various names have been given to the different forms of hairs. They are *clavate*, or *club-shaped*, gradually expanding from the base to their apex; *capitate* (fig. 42), having a distinct rounded head; *rough* or *scabrous*, with slight projections on their surface; *hooked* or *uncinate*, with a hook at their apex pointing downwards and to one side; *barbed* or *glochidiate*, with two or more hooks around the apex; *shield-like* or *peltate*, when attached by their middle, and projecting horizontally on either side, as in Malpighia urens (fig. 45), and in many Cruciferous plants; *cilia*, when surrounding the margin of leaves. On the pod of the Cowitch (Mucuna pruriens) hairs are produced with projections on their surface, which cause irritation of the skin. In Venus's Fly-trap (Dionæa muscipula) stiff hairs exist on the blades of the leaf (fig. 46), which, when touched, induce their closure.

Hairs occur on various parts of plants,—on the stem, leaves, flowers, seed-vessels, and seeds, and even in the interior of vessels. In the interior of the spathe of some Palms numerous ovate cells, analogous with hairs, occur in clusters, and can, when the spathe is dried, be shaken out in the form of powder. Cotton consists of the hairs surrounding the seeds of Gossypium herbaceum and other species of the genus. These when fresh are elongated tubular cells; when dried their walls collapse and they appear twisted. Hairs are occasionally developed to a great extent on plants exposed to elevated temperatures, as well as on those growing at high altitudes. When they occur on the organs of reproduction they are connected with fertilization, as the hairs on the style of Goldfussia, and the retractile hairs on the style of Campanula.

Different organs of plants are transformed into hairs,—as may be seen in the flowering stalks of the Wig-tree (Rhus Cotinus), and in the calyx of Compositæ.

Names are given to the surfaces of plants according to the presence or absence of hairs, as well as the nature of the hairs which cover them. The following are the more important terms;—*Glabrous*, smooth, having no hairs; *hairy* or *pilose*, furnished with hairs; *pubescent*, covered with soft, short, downy hairs; *villous*, having long, weak, often oblique hairs; *sericeous*, covered with long, closely appressed hairs, having a silky lustre; *hispid*, covered with long harsh or stiff hairs not appressed, *hirsute*, having long tolerably distinct hairs, not harsh nor appressed; *velvety* or *velutinous*, with a dense covering of short down, like velvet; *tomentose*, covered with crisp, rather rigid, entangled hairs like cotton, which form a sort of felt (*tomentum*); *woolly*, with long curled and matted hairs like wool; *bearded* or *stupose*, when hairs occur in small tufts. The hairs which are most frequently met with in plants are called *lymphatic*, from their not being connected with any peculiar secretion. Those, on the other hand, which have secreting cells at their base (fig. 43) or apex, are denominated *glandular*, and are not to be distinguished from glands. On young roots cellular projections occur, which may be called *radical* hairs. Young leaves and buds are frequently covered with protecting hairs. On the parts of the flower, as in the Iris, coloured hairs occur which have been called *corolline*.

In connection with the epidermal appendages we may notice glands, although they may occur in any tissue. A gland consists of a single cell or a collection of cells secreting substances different from those contained in the surrounding cells. In the former case the gland is simple, in the latter it is compound. In compound glands it frequently happens that the walls of the inner cells are absorbed, and thus the gland has only a single cavity, as in the glands of the Orange rind (fig. 28); these are termed *vesicular*. The secretion of the glands may be stored in their interior, as in Orange rind, and in the leaves of Laurus Camphora, or it may be exuded as in Lychnis viscaria, and in the nectaries of Fritillaria imperialis (fig. 50). Hairs serve as ducts through which the secretion of glands is discharged. Such hairs are seen in the Nettle (fig. 43), in Loasa or Chili Nettle, and in Malpighia (fig. 45), and are

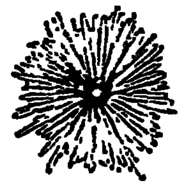


Fig. 44.

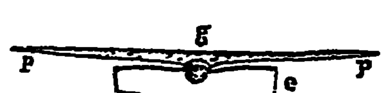


Fig. 45.

Fig. 46.

FIG. 44.—Radiating hair or scale from Elæagnus (*Oleaster*).
FIG. 45.—Peltate hair *pp* of *Malpighia urens* rising from *e*, epidermis, *g*, gland.
FIG. 46.—Irritable leaves of Venus's Fly-trap (*Dionæa*)

commonly called stings (*stimuli*). In the Nettle they are formed of a single conical cell, dilated at its base, and closed at first at the apex by a small globular disk placed obliquely. This disk breaks off on the slightest touch, when the sharp extremity of the hair enters the skin, and pours into the wound the irritating fluid which has been pressed out from the elastic epidermal cells at the base. When a nettle is grasped with violence, the sting is crushed, and hence no injury is done to the skin. The glandular enlarged apex of hairs sometimes exudes a viscid secretion, as in the Chinese Primrose and in the Sundew. The hairs of the latter plant, by this secretion, detain insects which happen to alight on them. The hairs gradually close on the insects, electrical phenomena taking place during the movement, and then the secretion from the glands becoming acid, an action takes place upon the organic matter analogous to that of the pepsin of the gastric juice, by which it is rendered soluble, and is eventually absorbed by the plant. A similar property is possessed by the secretion from the glands upon the surface of the leaf of Venus's Fly-trap (Dionæa muscipula, fig. 46). The acid in both instances belongs to the formic acid series. Glands may be either internal or external, and they may be situated at the extremity of a hair (when they are *stalked*), or they may be immersed in the substance of the plant (*sessile*). In the Dittany (Dictamnus albus, fig. 47) a form of gland is seen intermediate between the sessile and stalked form. The glands in this plant secrete a green oily matter, so also do the stalked glands in the Rose. In the Ice-plant the glands appear as elevations of the epidermis, containing a transparent fluid like ice, which is said to have an alkaline reaction; in the Chick-pea similar superficial cells contain an acid fluid. Clear glands are also seen on the under surface of the leaf of Passiflora lunata. Resinous glands are seen in the Hop (fig. 48) and Hemp plants. At the base of the petals of the Crown-imperial (fig. 50), cavities occur containing a honey-like fluid, secreted by what are called *nectariferous* glands.

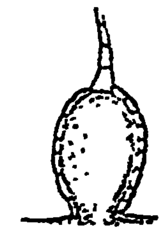


Fig. 47.
Gland of Dittany cut vertically.

Fig. 48.

Fig. 49.

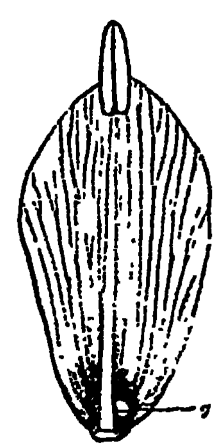


Fig. 50.

FIG. 49.—Superficial glands of the Hop, containing a resinous secretion called Lupulin.
FIG. 49.—Cluster of ovate-oblong glands from the base of the stipule of the Ipecacuan plant (*Cephaelis Ipecacuanha*).
FIG. 50.—One of the petals of *Fritillaria imperialis*, Crown Imperial, showing a pit or depression *g* at the base containing a honey-like secretion. This gland is sometimes called a nectary.

Cavities containing saccharine matter, surrounded by small thin-walled cells, are met with in the leaves of Acacia longifolia, also in Viburnum Tinus, and Clerodendron fragrans. The cavities communicate with the surface of the leaves by means of canals. Peculiar sessile glands secreting a gummy substance are found at the inner side of the base of the petioles of Cinchona and Ipecacuan plants (fig. 49). On the buds of various trees peculiar glandular hairs termed *colleters* exist, secreting a gummy mucilaginous matter, the *blastocolla*, which covers the bud. These, however, disappear on the bursting of the bud. They

seem to have a protective function. The secretions of glands are very various, oily, waxy, resinous, gummy, saccharine, acid, &c.

ORGANS OF PLANTS.

Having now considered the elementary structures and tissues found in the Vegetable Kingdom, we proceed to view them in combination to form the plant. The simplest plant is found amongst Algæ, where, as in the Red-snow plant (Protococcus nivalis, fig. 51) the whole organism consists of a single isolated cell. Other Algæ and all Fungi and Musci are composed of a number of cells united in various ways; whilst in Ferns and their allies and all flowering plants vessels are formed in addition to the cells. The plants in which the tissues are entirely cellular are termed *cellular* plants; those in which vessels are also found are *vascular* plants.

Fig. 51.

Cells of the Red-snow plant (*Protococcus nivalis*), in different stages of growth and development. *a*, cell in the young state; *b*, cell fully formed, with cellules in its interior ready to be discharged, and to form independent plants; *c*, cell after its contents have been discharged.

That the portions of a plant may be properly maintained two functions have to be performed, namely, *nutrition*, on the proper performance of which the life of the individual plant depends, and *reproduction*, by which the perpetuation of the type is provided for. In such a simple form as the Red-snow plant (fig. 51) those functions are performed by the single cell. In the plants composed of numerous cells a differentiation takes place by which special cells are set apart for particular functions, and thus certain organs are formed in the plant. In the higher plants those organs become more complicated from the introduction of the vascular element.

The nutritive organs of plants are generally known as the *root*, the *stem*, and the *leaves*. In all vascular plants and the higher cellular plants an axis or stem having roots and bearing leaves is distinguishable, and such plants have been designated *Cormophytes* or *Phyllophytes*. In the lower class of cellular plants, as Fungi and Algæ, no such distinction is possible, and there is merely a flattened leafy expansion with dependent filiform processes; this structure has been termed a *thallus*, and such plants are *Thallogens* or *Thallophytes*.

Amongst the higher plants the reproductive organs are,

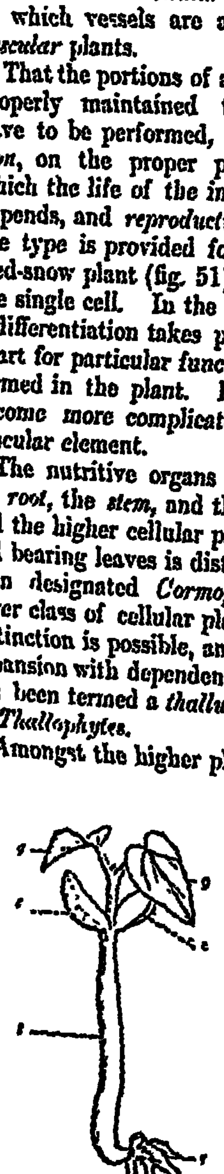


Fig. 52.

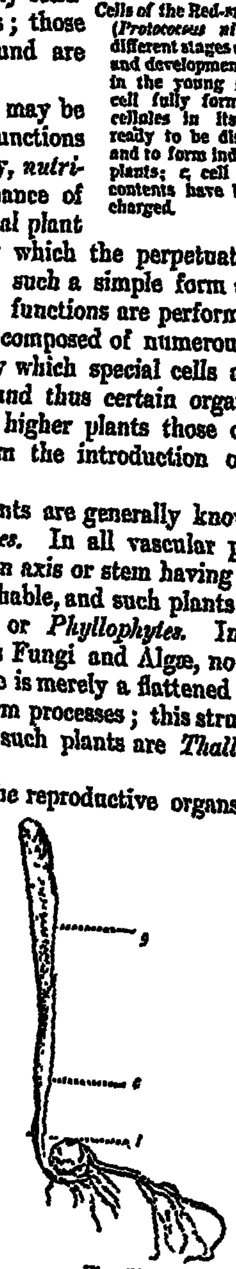


Fig. 53.

Fig. 52.—Haricot or French Bean, a Dicotyledonous plant, germinating. *r*, the roots coming off from the radicular end of the axis; *t*, the hypocotyledonary portion of the axis bearing the cotyledons *c*, *c*; the young stem and leaves, *g*, *g*.
Fig. 53.—Grain of Maize or Indian Corn, a Monocotyledonous plant, germinating. Roots coming off from lower end of *t*, the axis; *c*, the single cotyledon; *g*, the young stalk and leaves.

in ordinary language, comprehended under the term flower; and, as they are conspicuous, such plants have been denominated *Flowering*, *Phanerogamous*, or *Phænogamous*. Amongst all cellular plants and in some vascular plants, as Ferns and Equisetum, there are no flowers, and the reproductive organs are inconspicuous, hence they have been termed *Flowerless* or *Cryptogamous*. In all cases the young plant, or embryo, is completely cellular. But as growth proceeds, that differentiation takes place which distinguishes the several classes of plants one from the other. In Phanerogams the first leaves produced upon the embryo plant are termed primary, seed-lobes, or *cotyledons*. In some cases these are two in number, and are opposite one another. Plants in which this occurs are *Dicotyledonous* (fig. 52), as our ordinary forest trees. In other plants the lobes alternate and only one cotyledon is formed; such are *Monocotyledonous* (fig. 53), as Grasses, Lilies. In Cryptogams, on the other hand, no such seed-lobes or cotyledons are produced, and they are *Acotyledonous* (fig. 54).

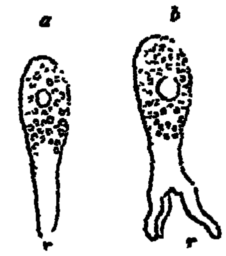


Fig. 54.

Germinating spores of a cellular plant (*Prolifera rivularis*). *a*, spore giving out a conical root-like process *r*, while the other extremity, containing a nucleus and granules, forms a cellular frond; *b*, the same spore, with the root-like process *r*, dividing. No cotyledons are produced.

Primary tissue.

In all plants the original cell tissue which gives origin to its parts is of a uniform nature, and is termed the *primary tissue*. When all the cells of this tissue are capable of multiplication and division the tissue is a *meristem* or *generating tissue*. If the cells are not so capable, then it is a *permanent tissue*. The primary tissue at the growing point of any shoot or root is essentially a meristem, and it has been designated the *primary meristem* to distinguish it from the *secondary meristem*, which is applied to a tissue in the older parts of a stem or root which remains or becomes capable of division. The growing point of the apex has been termed the *punctum vegetationis*, and it not unfrequently forms a conical projection, and is then the *vegetative cone*. By growth at this punctum vegetationis the shoot or root increases in length, and the mode of addition is in many cases of a definite character. Two chief types of growth are recognized. In one of these a single large cell is always present at the apex, termed the *apical cell*, which may be regarded as the mother-cell, whence by bipartition in a definite manner the whole meristem below it has arisen, as is well seen in vascular Cryptogams and cellular plants. The other type is seen in Phanerogams, and here no such apical cell is visible, but a number of cells are found at the apex by whose multiplication the subsequent tissues are formed. But in whatever way formed, a primary meristem is the result of all the processes of growth, and by differentiation of its cells the various parts of the shoot or root are formed. The outer layer of the primary meristem, which extends completely over the punctum vegetationis, is termed the *dermatogen*; it is the primordial epidermis, being continuous with the epidermis of the shoot and afterwards becoming epidermis. Underneath the dermatogen several layers of cells are distinguished, continuous with the cortical portion of the shoot or root; this is the primordial cortex, and constitutes the *periblem*. Enclosed by this is a central cellular mass, out of which the fibro-vascular bundles and the structures of the central part of the shoot or root are formed; this has been termed the *plerome*. If the growing axis be a young root there is in addition developed, usually from the dermatogen, a mass of cells at the extremity, constituting a *root-cap*, or protective covering, to the delicate meristematic cells beneath; no such structure is formed in a stem. Thus a stem is structurally distinct from a root in having no root-cap.

In the plerome the fibro-vascular bundles are formed. Certain cells become elongated and prosenchymatous and united in bundles leaving no intercellular spaces; Fibro-vascular bundles.

this mass is termed the *procambium* of the fibro-vascular bundle. As growth proceeds changes take place in the cells by thickening, and, their contents disappearing, various kinds of cells and vessels are formed. In this way the whole mass of the procambium may be converted into permanent tissue, and then growth ceases; or an inner portion of the bundle remains merismatic, which is called the *cambium*, and then growth proceeds, the shoot or root increasing in thickness by the cambium forming new cells on both sides In the former case the bundle is *closed*, as in Cryptogams and Monocotyledons and some Dicotyledons; in the latter it is *open*, as in most Dicotyledons and Conifers. In every fibro-vascular bundle a separation into two groups of structures may be distinguished—the wood or xylem layers; and the bast or phloëm layers. As long as the bundle is open and cambium present, these layers are separated by the cambium (fig. 55). Their

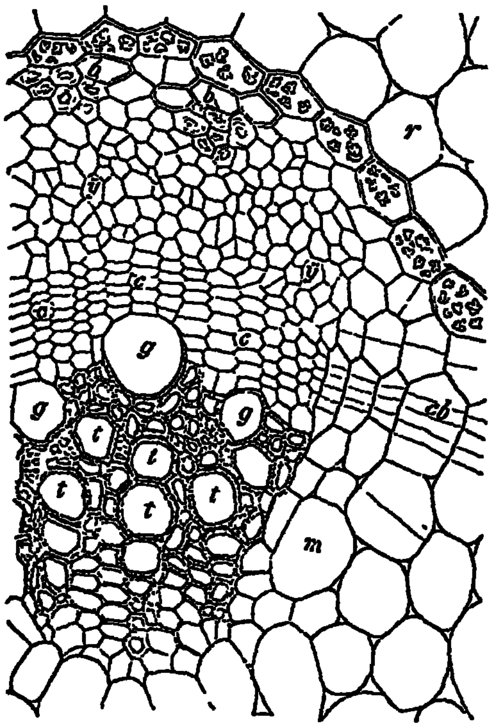


Fig. 55.

Transverse section of an open fibro-vascular bundle. *c*, cambium; *cb*, continuation of cambium between the fibro-vascular bundles; *g*, large pitted vessels; *t* smaller pitted vessels and spiral vessels intermixed with wood-cells; *y*, inner phloëm layers; *b*, bast fibres; *m* is the parenchyma of the pith; *r* is the cortical parenchyma. Immediately external to the bark lies the bundle sheath of cells filled with starch. (*Sachs.*)

relative position as regards the axis of the stem or root

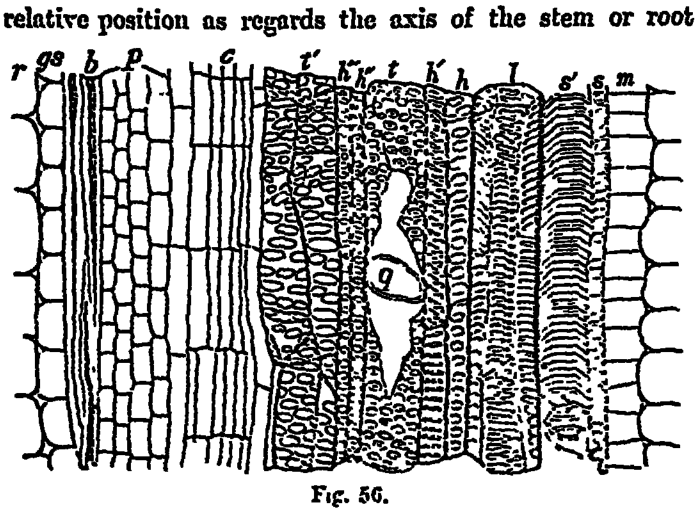


Fig. 56.

Longitudinal section of an open fibro-vascular bundle. *c*, cambium: *s*, *s'*, spiral vessels with fibres which can be unrolled: *l*, scalariform reticulated vessel; *h*, *h'*, *h''*, *h'''*, wood-cells: *t*, bordered pitted vessel: *t'*, young pitted vessel: *p*, inner phloëm layer: *b*, bast layer: *gs*, bundle-sheath: *r*, cortical parenchyma: *m*, pith parenchyma. The elements are developed from *s* to *t'* in the xylem portion. (*Sachs.*)

varies. In some cases the phloëm is nearer the circumference, in other instances the xylem is peripheral, and in rare cases amongst Dicotyledons there are phloëm layers both on the outer and inner sides of the fibro-vascular bundles. In vascular Cryptogams the phloëm layers always surround the xylem portion of the bundle.

In the xylem or wood portion of a fibro-vascular bundle the cells all tend to thicken their walls, and, consequently, numerous kinds of cells and vessels are found, which are usually arranged in a definite manner. On the side furthest removed from the phloëm we find spiral vessels interspersed with wood-cells (figs. 55 and 56), outside are reticulated and scalariform vessels, and then interspersed with wood cells are large pitted vessels. In the phloem or bast layers the cells have not such a tendency to thicken, but usually remain thin-walled, forming ordinary parenchymatous cells, or becoming perforated and forming sieve cells. In certain layers, however, the cell-walls are thickened so as to become flexible, constituting the bast fibres. Around every fibro-vascular bundle a single layer of cells of the fundamental cellular tissue of the stem is marked off from its surroundings, the cells get filled with starch-grains, and this constitutes what has been termed the *bundle sheath* or starch-bearing layer (fig. 57). In fig. 57 is seen a transverse section of the closed fibro-vascular bundle from the Maize, and it will be observed that it is essentially the same as that of the open bundle (fig. 55), only that all the cambium cells have passed into permanent tissue.

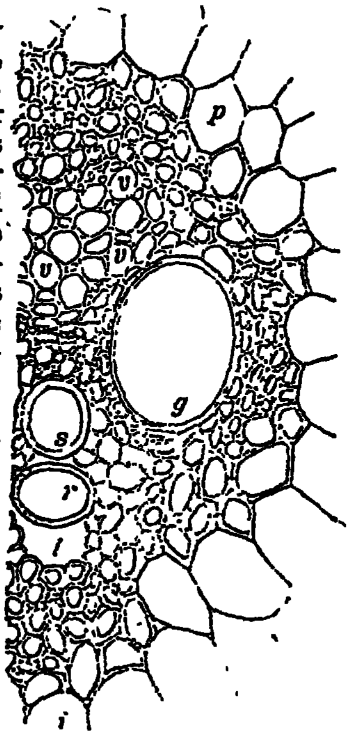


Fig. 57.

Transverse section of a closed fibro-vascular bundle. *r*, annular vessel: *s*, spiral vessel: *l*, inter-cellular canal; *g*, pitted vessel, *r.r*, cambiform tissue which has become permanent. Between *r* and *s* are reticulated vessels. *p*, surrounding parenchyma. Outer cells *a* of the bundle are parenchymatous, *i* marks the inner side of the bundle. (*Sachs.*)

In all plants a provision is made for branching of the various organs, and two principal forms of it may be recognized. In one of these the generating axis elongates at the apex, producing in succession lateral structures. To this form the term *monopodium* has been applied. In the second form there is a cessation of growth at the apex in the direction of previous elongation of the axis, and a continuance in two diverging directions. This is *dichotomous* branching. In their rudimentary state all branchings may be easily referred to one or other of those types; but in the mature system it is frequently difficult to recognize the type, owing to irregular development of the successive branching. Thus in a dichotomous branching only one of the secondary axes may develop strongly, the weaker branch appearing as a small lateral shoot from its base, and an apparent primary shoot is thus produced which in reality consists of the bases of single branches of consecutive forkings. Such an axis is termed a *pseudaxis* or *sympodium*. And, again, in monopodial branchings the primary axis may continue to develop more strongly than its lateral axes, which in their turn develop similarly, and a *racemose* form arises; or the primary axis may be arrested in growth, and the secondary axes develop more strongly and overtop it, when a *cymose* branching results. More will be said on this subject when considering the inflorescence of Phanerogams, in which the various forms of branching are well seen.

We now proceed to consider the form and internal structure of the various organs of plants.

I. ORGANS OF NUTRITION.

1. *Root or Descending Axis.*

ot. Speaking generally, the root is that portion of the plant which descends into the soil. In all plants the root is at first entirely cellular. It may remain permanently so, or vessels may be formed in it. The *Radicle*, or young root (fig. 58, *r*), is the first portion of the embryo protruded from the seed or spore (fig. 54) when germination commences, and resembles very much in structure the young stem. Both are entirely cellular, consisting of a central nucleus of cellular tissue covered by two or more layers of cells. But at the apex of the root a mass of cells is developed, which constitutes what is known as the root-cap or *pileorhiza*. These cells extend for some distance along the sides of the root, forming a sheath, and in some cases, as Lemna, the cap becomes loosened from the root, remaining attached by a few cells at the apex only, and then it is known as the *ampulla*. This root-cap distinguishes structurally the root from the stem, and it serves as a protection to the apical growing-point of the root. The roots of Thallophytes, consisting entirely of cells, do not develop a root-cap.

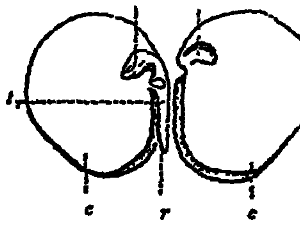


Fig. 58.

The dicotyledonous embryo of the Pea laid open. *c*, *c*, the two fleshy cotyledons, or seed-lobes, which remain under ground when the plant sprouts; *r*, the radicular extremity of the axis whence the root arises; *t*, the axis bearing the young stalk and leaves *g*, which lie in a depression of the cotyledons *f*.

The root is merely a prolongation downwards of the stem, and the part where they unite is the *collum* or *neck*. Afterwards the root is distinguished from the stem by the absence of a provision for the development of leaf-buds. It is not always easy to distinguish between a stem and a root. Many so-called roots bear at their upper part a portion called their *crown*, whence leaf-buds arise. Underground stems and roots are often confounded. Some plants, as the Moutan Pæony, the Plum-tree, Pyrus japonica, and especially Anemone japonica, have a power of forming buds on what are commonly called their roots. The last-mentioned plant develops these buds on every part of its extensively ramifying root-like prolongations, which may be chopped into numerous pieces, each capable of giving rise to a new plant. Such is also the case with the annulated root of Ipecacuan. Roots are usually subterranean and colourless. Externally, they have a cellular epidermal covering of a delicate texture, sometimes called *epiblema*, in which no stomata exist. In woody plants fibro-vascular bundles are found in the roots, and there is an internal arrangement of tissues similar to that seen in the stem itself, but spiral vessels are rare in the root. The axis of the root gives off branches which divide into radicles or fibrils, the extremities of which, composed of delicate cellular tissue constituting the *punctum vegetationis*, have been erroneously called *spongioles* or *spongelets*; they are not distinct organs. Hairs are often seen on roots, but no true leaves. These hairs consist of simple elongated cells, which occur singly, and appear to serve the purpose of absorption. Roots increase principally by additions to their extremities, which are constantly renewed, so that the minute fibrils serve only a temporary purpose, and represent deciduous leaves; but in large trees which form thick roots an increase in diameter occurs in the root similar to what is seen in the stem itself. In some plants no roots are formed at all, thus in the Orchidaceous plants Epipogium Gmelini and Corallorhiza innata, and also in Lemna arrhiza, no roots occur. Roots may be given off from any portion of a stem, originating as cellular prolongations from the inner portion of the stem, and coming off at any point of the stem, or at small lenticular points to which the name of *lenticels* has been given by some. When the stem is more or less horizontal the roots given off from it pass directly into the soil; but if the stem be erect they pass for a certain distance downwards through the air, and are called *aerial*. The latter are well seen in the Screw-pine (Pandanus), the Banyan (Ficus indica, fig. 59), and

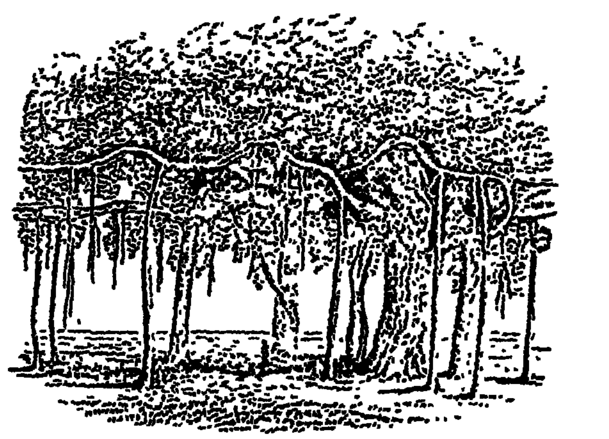


Fig. 59.

Ficus indica, the Banyan tree, sending out numerous aerial roots, which reach the soil, and prop the branches.

many other species of Ficus, where they assist in supporting the stem and branches. In the Mangrove they often form the entire support of the stem, which has decayed at its lower part. In Tree-ferns they form a dense coating around, and completely concealing, the stem; such is also the case in some Dracænas and Palms. In *Epiphytes*, or plants growing in the air, attached to the trunks of trees, such as Orchids of warm climates, the aerial roots produced do not reach the soil; they continue always aerial and greenish, and they possess stomata. Delicate hairs are often seen on these epiphytal roots, as well as a peculiar investment formed by the cells of the epidermis which have lost their succulent contents and are now filled with air. This layer is called *velamen radicum*, or covering of the roots. The aerial roots of the Ivy are not the nutritive roots of the plant, but are only intended for mechanical support.

Parasitic plants, as the Mistleto (Viscum), Broom-rape (Orobanche), and Rafflesia, send root-like processes into the substance of the plants whence they derive nourishment. In the Dodder (Cuscuta), the tissue around the roots swells into a kind of sucker (*haustorium*), which is applied flat Plate X.
upon the other plant, and ultimately becomes concave, so as to attach the plant by a vacuum. From the bottom of the sucker the root protrudes, which penetrates the supporting body. In the case of parasitic Fungi, such as Mould, there are cellular filaments which spread among the tissues of plants, and which may be looked upon as equivalent to roots and stems united. They form the *spawn* or *mycelium* of these plants, and in some cases cause rapid destruction of the tissues of plants, as in the disease called Dry-rot.

The forms of roots depend upon the mode in which the axis descends and branches. The mode of branching of roots is almost universally monopodial, only in Lycopodiaceæ is it dichotomous. When the central axis goes deep into the ground in a tapering manner, without dividing, a *tap-root* is produced. This kind of root is sometimes shortened, and becomes succulent, forming the *conical* root of Carrot, or the *fusiform* or spindle-shaped root of Radish, or the *napiform* root of Turnip. In ordinary forest trees the first root protruded continues to elongate and forms a long

primary root-axis, whence secondary axes come off. In other plants, especially Monocotyledons, the primary axis soon dies and the secondary axes take its place. When the descending axis is very short, and at once divides into thin, nearly equal, fibrils, the root is called *fibrous*, as in many Grasses (fig. 60); when the fibrils are thick and succulent the root is *fasciculated*, as in Ranunculus Ficaria,
VII. Asphodelus luteus, and Œnanthe crocata; when some of the fibrils are developed in the form of tubercules,

Fig. 60.

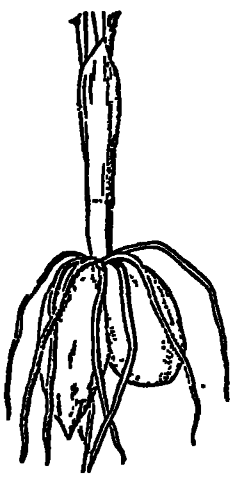


Fig. 61.

Fig. 62.

FIG. 60.—Fibrous root of a Grass. Numerous fibrils coming off from one point.
FIG. 61.—Orchis, showing tubercules or tuberous roots, which contain a gummy matter called bassorin.
FIG 62.—An epiphytic Orchid with pseudo-bulbs.

the root is *tubercular*, as in Orchis (fig. 61); when the fibrils enlarge in certain parts only, the root is *nodulose*, as in Spiræa Filipendula, or *moniliform*, as in Pelargonium triste, or *annulated*, as in Ipecacuan. Some of these so-called roots are formed of a stem and root combined, and when cut in pieces they give rise to buds and new plants. In some cultivated plants, as Turnip, the central root is sometimes injured, so as to end abruptly, and it then divides into numerous branches, resembling a fasciculated root. This gives rise to the disease called Fingers and Toes, which is very injurious to the crop. Anbury is a disease where a clubbing of the root takes place. The mode in which the fibres of roots are produced and developed gives origin to different forms of rhizotaxis, or root-arrangement.

Roots either fix the plant in the soil or attach it to other bodies. They absorb nourishment by a process of imbibition or endosmose through their cellular extremities. The elongation of the roots by their extremities enables them to accommodate themselves to the soil, and allows the extremities of the rootlets to extend deeply without being injured. Roots, in their lateral extension, bear usually a relation to the horizontal spreading of the branches, so as to fix the plant firmly, and to allow fluid nutritive substances to reach the absorbing extremities. As has been already stated, the structure of perennial roots is identical with that of the stem. Thus in Dicotyledons we find a pith, medullary rays, zones of wood, cambium layers, and bark, although no medullary sheath is present. In Monocotyledons we have fibro-vascular bundles distributed in a matrix of cellular tissue. The young primary root in Monocotyledons differs from that in Dicotyledons in that it rises deeply within the embryonal tissue, and on germination this tissue is ruptured and forms a sheath, around the base of the roots, called *coleorhiza*. Amongst Monocotyledons the primary roots usually soon die, and secondary roots are formed in abundance. In vascular Dicotyledonous plants the structure of the root is similar to that of the stem. In Thallogens the roots consist merely of simple or branching filamentous hair-like structures. In some large tropical Seaweeds the root-like bodies develop to a large extent, but serve only as fixing organs, and take no share in nourishing the plant.

2. *Stem or Ascending Axis.*

A stem may be defined as an axis bearing leaves. Stem.
Structurally it differs from a root in having no development of cells forming a cap over the growing point. Under the term *caulome* (stem structure) are included all those parts of a plant morphologically equivalent in bearing leaves. The stem generally ascends, seeking air and light, and has therefore been termed the *ascending axis*. Stems have usually considerable firmness and solidity, but sometimes they are weak, and either lie prostrate on the ground, thus becoming *procumbent*, or climb on plants and rocks by means of rootlets, like the Ivy, being then called *scandent*, or twist round other plants in a spiral manner like Woodbine, when they are *volubile*. Twining plants turn either from right to left, as the French Bean, Convolvulus, Passion-flower, Dodder, Periploca, and Gourd; or from left to right Plate X.
as Honeysuckle, Twining Polygonum, Hop, and Tamus. Bryony tendrils twine from right to left, and left to right, alternately. In warm climates twining plants (*lianas*) often form thick woody stems; while in temperate regions they are generally herbaceous. Exceptions, however, occur in the case of the Clematis, Honeysuckle, and Vine; the twining stem of the vine has been called *sarmentum*. Some stems are developed more in diameter than in height, and present a peculiar shortened and thickened aspect, as Testudinaria or Tortoise-plant, Cyclamen, Melocactus, Echinocactus, and other Cactaceæ; while in many Orchids (fig. 62) the stem assumes an oval or rounded form, and is called a *pseudo-bulb*.

Names are given to plants, according to the nature and duration of their stems. *Herbs*, or *herbaceous* plants, have stems which die down annually. In some of them the whole plant perishes after flowering; in others, the lower part of the stem forming the *crown of the root* remains, bearing buds from which the stem arises next season. In what are called *biennial* herbs, the whole plant perishes after two years, while in *perennial* herbs the crown is capable of producing stems for many years, or new annual products are repeatedly added many times, if not indefinitely, to the old stems. The short permanent stem of herbaceous plants is covered partially or completely by the soil, so as to protect the buds. Plants producing permanent woody stems are called *trees* and *shrubs*. The latter are less than five times the height of a man, and produce branches from or near the ground; while the former have conspicuous trunks, which attain at least five times the height of a man. Shrubby plants of small stature are called *under-shrubs* or *bushes*. The limits between these different kinds of stem are not always well defined; and there are some plants occupying an intermediate position between shrubs and trees, to which the name of *arborescent* shrubs is occasionally given. The stem receives the name of *caulis* in ordinary herbaceous plants which do not form a woody stem, *culm* in grasses, *truncus* in trees, *caudex* or *stock* in Palms and in some Cacti, and *stipe* in Ferns. The term *haulm* is probably a corruption of culm; it is used by farmers to designate the stem of grasses and the herbaceous stems of plants. The stem is not always conspicuous. Plants with a distinct stem are called *caulescent*; those in which it is inconspicuous are *acaulescent*, as the Primrose, Cowslip, Gentian, and Dandelion. A similar term is given in ordinary language to plants whose stems are buried in the soil, such as Cyclamen or Sowbread. Some plants are truly stemless, and consist only of expansions of cellular tissue representing stem and leaf, called a *thallus*, and hence are denominated *Thallogens*, or *Thallophytes*.

Stems have a provision for a symmetrical arrangement [illegible]

of leaves and branches,—*nodes*, or points whence leaf-buds are produced, being placed at regular intervals. No such provision occurs in roots. The intervals between nodes are called *internodes*. The stem, although it has a tendency to rise upwards when first developed, in many instances becomes prostrate, and either lies along the ground partially covered by the soil, or runs completely underneath its surface, giving off roots from one side and buds from the other. Some stems are therefore subterranean, and are distinguished from roots by the provision made for regular leaf-buds. The first rudiment of the young stem in the embryo appears outside the seed or spore after the radicle has been protruded. It is termed the *plumule* (fig. 58), and differs from the radicle in the absence of a root-cap and in its tendency to ascend. The apical growing portion of the young stem constitutes the terminal bud of the plant, and by its development the stem increases in height; but in addition there is a provision for the production of lateral buds, which develop into lateral shoots more or less resembling the parent stem, and by these the branching of the plant is determined. These buds are found in the *axil* of previously-formed leaves; or, in other words, in the angle formed between the stem and leaf. They are hence called *axillary*. They are produced always from the outer portion of the stem except in the case of Equisetaceæ (Horsetails), where they have a deep-seated origin. At first they consist entirely of cellular tissue, but in the progress of growth vascular bundles are formed in them continuous with those of the stem, and ultimately branches are produced, which in every respect resemble the axis whence the buds first sprang. As the axis of the bud increases in length, cellular projections appear at regular intervals upon the primary meristem, which are the rudimentary leaves.

Buds, as has been stated, are either terminal or lateral. By the production of the former, stems increase in length, while the latter give rise to *branches* (*rami*), from which others, called *branchlets* or *twigs* (*ramuli*), arise, and add to the diameter of the stem. The terminal bud, after producing leaves, sometimes dies at the end of one season, and the whole plant, as in annuals, perishes; or part of the axis is persistent, and remains for two or more years, each of the leaves before its decay producing a bud in its axil. This bud continues the growth in spring. In ordinary trees, in which there is provision made for the formation of numerous lateral buds, any injury done to a few branches is easily repaired; but in Palms, which only form terminal buds, and have no provision for a lateral formation of them, an injury inflicted on the terminal bud is more likely to have a prejudicial effect on the future life of the plant. In the trees of temperate and cold climates the buds which are developed during one season lie dormant during the winter, ready to burst out under the genial warmth of spring. They are generally protected by external modified leaves in the form of *scales* (*tegmenta* or *perulæ*), which frequently exhibit a firmer and coarser texture than the leaves themselves. They serve a temporary purpose, and usually fall off sooner or later, after the leaves are expanded. The bud is often protected by a coating of resinous matter, as in the Horse-chestnut and Balsam Poplar, or by a thick downy covering, as in the Willow. Linnæus called leaf-buds *hibernacula*, or the *winter quarters* of the young branch. In some plants, as in Platanus, the buds destined to live through the winter are so completely surrounded by the base of the petiole as not to be visible until the leaf has fallen off. These are said to be *intrapetiolar*.

In the bud of a common tree, as the Sycamore (fig. 63), there is seen the cicatrix left by the leaf of the previous year *c*, with the pulvinus or swelling *p*, then the scales *e*, *e*, arranged alternately in a spiral, and overlying each other in what is called an *imbricated* manner. On making a transverse section of the bud (fig. 64), the

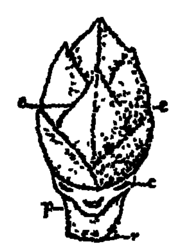


Fig. 63.

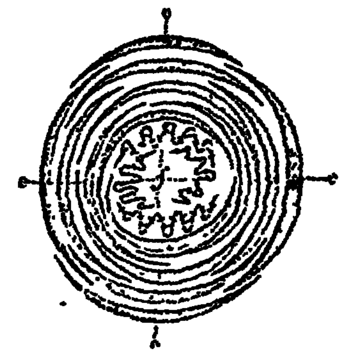


Fig. 64.

FIG. 63.—Leaf-bud of Sycamore (*Acer Pseudo-platanus*) covered with scales.
FIG. 64.—Transverse section of the same leaf-bud.

overlying scales *e*, *e*, *e*, *e*, are distinctly seen surrounding the leaves *f*, which are plaited or folded round the axis or growing-point. In plants of warm climates the buds are often formed by the ordinary leaves without any protecting appendages; such buds are called *naked*. A bud may be removed in a young state from one plant and grafted upon another by the process of *budding*, so as to continue to form its different parts; and it may even be made to grow in the soil, in some instances, immediately after removal. In some trees of warm climates, as Cycas, Plates XV.
Papaw-tree, Palms, and Tree-ferns, growth by terminal and VI.
buds is well seen. In these plants the elongation of the stem is generally regular and uniform, so that the age of the plant may be estimated by its height; owing to this mode of growth they do not attain a great diameter. Although provision is made for the regular formation of buds, there are often great irregularities in consequence of many being abortive, or remaining in a dormant state. Such buds are called *latent*, and are capable of being developed in cases where the terminal bud, or any of the branches, have been injured or destroyed. In some instances, as in Firs, the latent buds follow a regular system of alternation; and in plants with opposite leaves, it frequently happens that the bud in the axil of one of the leaves only is developed, and the different buds so produced are situated alternately on opposite sides of the stem. Occasionally, after a partial development as branches, buds are arrested and form knots or nodules. The embryo-buds or nodules of the Beech, Cedar, and Olive are apparently of this nature.

When the terminal bud is injured or arrested in its growth the elongation of the main axis stops, and the lateral branches often acquire increased activity. By continually cutting off the terminal buds, a woody plant is made to assume a bushy appearance, and thus *pollard* trees are produced. Pruning has the effect of checking the growth of terminal buds, and of causing lateral ones to push forth. The peculiar bird-nest appearance, often presented by the branches of the common Birch, depends on an arrestment in the terminal buds, a shortening of the internodes, and a consequent clustering or fasciculation of the twigs. In some plants there is a natural arrestment of the main axis after a certain time, giving rise to peculiar shortened stems. Thus the crown of the root is a stem of this nature, forming buds and roots. Such is also the case in the stem of Cyclamen, Testudinaria Elephantipes, and in the tuber of the Potato. The production of lateral in place of terminal buds sometimes gives the stem a remarkable zigzag aspect. Branches are sometimes arrested in their progress at an early stage of their development, and do not appear beyond the surface of the stem; at other times, after having grown to a considerable size, they undergo decay. In both instances the lower part of the

branch becomes embedded and hardened among the woody layers of the stem.

ıches. The mode in which branches come off from the stems gives rise to various forms of trees, as pyramidal, spreading, or weeping,—the angles being more or less acute or obtuse. In the Italian Poplar and Cypress the branches are erect, forming acute angles with the upper part of the stem; in the Oak and Cedar they are spreading or patent, forming nearly a right angle; in the Weeping Ash and Elm they come off at an obtuse angle; while in the Weeping Willow and Birch they are pendulous from their flexibility. The comparative length of the upper and under branches also gives rise to differences in the contour of trees, as seen in the conical form of Spruce, and the umbrella-like form of the Italian Pine (*Pinus Pinea*). The branching of some trees is peculiar. In the Amazon district many Myristicaceæ and Monimiaceæ have verticillate branches coming off in fives. This is also seen in the Chili Pine. Some Amazon trees taper downwards, so as to have a form like an inverted cone or pyramid, as in the Mulatto tree (Eukylista Spruceana), one of the Cinchonaceæ.

Branches are sometimes long and slender, and run along the ground, producing buds with roots and leaves at their extremity or apex. This is seen in the *runner* (*flagellum*) of the Strawberry. In the Houseleek (Sempervivum) there is a similar prostrate branch of a shorter and thicker nature, producing a bud at its extremity capable of independent existence. It receives the name of *offset* (*propagulum*). In many instances the branch decays, and the young plant assumes a separate existence. Gardeners propagate plants by the process of *layering*, which consists in bending a twig, fixing the central part of it into the ground, and, after the production of roots, cutting off its connection with the parent. A *stolon* differs from these in being a branch which curves towards the ground, and, on reaching a moist spot, takes root and forms an upright stem, and ultimately a separate plant. This is a sort of natural layering, and the plant producing such branches is called *stoloniferous*. In the Rose and Mint a subterranean branch arises from the stem, which runs horizontally to a certain extent, and ultimately sends up an aerial stem, which becomes an independent plant. Such branches are denominated *suckers*, and the plants are *surculose*. The gardener divides the connection between the sucker and the parent stem, in order to propagate these plants. In the case of Asparagus and other plants which have a perennial stem below ground, subterranean buds are annually produced, which appear above ground as shoots or branches covered with scales at first, and ultimately with true leaves. The young shoot is called a *turio*. These branches are herbaceous and perish annually, while the true stem remains below ground ready to send up fresh shoots next season. In Bananas and Plantains the apparent aerial stem is a shoot or leaf-bud sent up by an underground stem, and perishes after ripening fruit. Branches are sometimes arrested in their development, and, in place of forming leaves, become transformed into *spines* or *thorns*, as in the Hawthorn. Plants which have spines in a wild state, as the Apple and Pear, often lose them when cultivated, in consequence of their being changed into branches; in some cases, as in the Sloe (Prunus spinosa), (fig. 65), a branch bears leaves at its lower portion, and terminates in a spine. Plants bearing thorns (modifications of branches or leaves) are denominated *spiny*, *spinose*, or *spinescent*. A bud is sometimes developed as a slender spiral or twisted branch, called a *tendril* or *cirrus*. In the Passion-flower the lateral buds are thus altered, with the view of enabling the plant to climb. In the Vine the tendrils are looked upon as the terminations of separate axes, or as transformed terminal buds, and are sometimes called *sarmenta*. In the Vine there are no young buds seen in the angle between the stem and leaves, nor between the stem and tendrils; and the latter are not axillary.

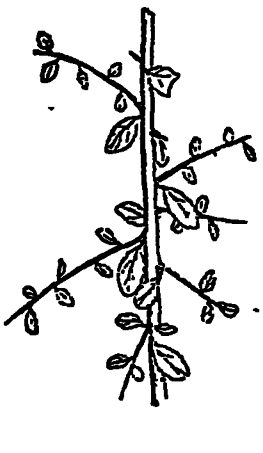


Fig. 65.

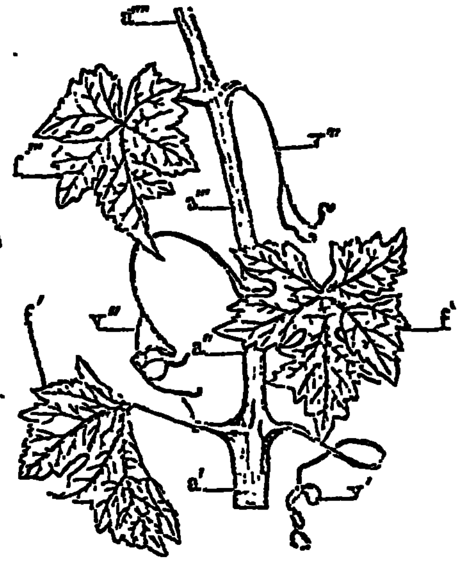


Fig. 66.

FIG. 65.—Branch of the Sloe (*Prunus spinosa*) producing spines or thorns which are abortive branches, as shown by their bearing leaves.
FIG. 66.—Portion of a branch of the Vine (*Vitis vinifera*), on which the terminal buds are converted into tendrils.

Fig. 66 represents the branch of a Vine, in which a' is the primary or first formed axis, ending in v', a tendril or altered terminal bud, and having a leaf f' on one side. Between this leaf and the tendril, which represents the axis, a leaf-bud was formed at an early date, producing the secondary axis, or branch a'', ending in a tendril v'', with a lateral leaf f'', from which a tertiary axis or branch a''' was developed, ending in a tendril v''', and so on. The tendrils of Ampelopsis Veitchii are terminated by disks which secrete a sticky matter, by means of which they adhere to walls, &c. The tendrils, like those of the Vine, are modifications of the axis. Tendrils twist in a spiral manner, and enable the plants to rise into the air by twining round other plants. The direction of the spiral frequently differs from that of the climbing stem which produces the tendril. In the Vine the lower part of the stem is strong, and needs no additional support; the tendrils therefore occur only in the upper part, where the branches are soft, and require aid to enable them to support the clusters of fruit. In the Bryony the tendril in the first part of its course twines from right to left, and in the last from left to right.

In some instances lateral buds are found without being in the axil of leaves. In this case they are *extra-axillary*. Such buds are produced after the stem and leaves have been formed, and in certain circumstances they are developed like normal buds. What have been called *embryo-buds* are woody nodules seen in the bark of the Beech, Elm, and other trees. They are partially developed adventitious or abnormal buds, in which the woody matter is pressed upon by the surrounding tissue, and thus acquires a very hard and firm texture. When a section is made, they present woody circles arranged around a central pith, and traversed by medullary rays. The nodules sometimes form *knots* on the surface of the stem, at other times they appear as large *excrescences*, and in some cases twigs and leaves are produced by them.

Buds sometimes become extra-axillary in consequence of the non-appearance or abortion of one or more leaves, or on account of the adhesion of the young branch to the parent stem. In place of one bud there are occasionally several accessory ones produced in the axil, giving origin to numerous branches. Such an occurrence is traced to the presence of latent or adventitious buds. By the union of several such buds, branches are produced, having

a thickened or flattened appearance, as is seen in the Fir, Ash, and other trees. These *fasciated* branches, in some cases, however, are owing to the abnormal development of a single bud. Occasionally adventitious buds are produced on the edges of leaves, as in Bryophyllum calycinum (fig. 67), Malaxis paludosa, and various species of Asplenium, and on the surface of leaves, as in Ornithogalum thyrsoideum. These are capable of forming independent plants. Similar buds are also made to appear on the leaves of Gesnera, Gloxinia, and Achimenes, by wounding various parts of them, and placing them in moist soil; this is the method often pursued by gardeners in their propagation. The Ipecacuan plant has been propagated by means of leaves inserted in the soil. In this case the lower end of the leaf becomes thickened like a corm, and from it roots are produced, and ultimately a bud and young plant. Leaves bearing buds on their margin are called *proliferous*.

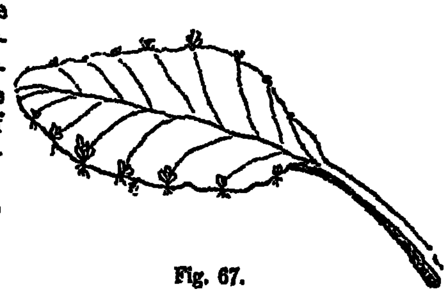


Fig. 67.

Leaf of *Bryophyllum calycinum*, producing buds along the margin, at the extremities of the primary veins.

The typical form of stems is rounded. They are sometimes compressed or flattened laterally, while at other times they are angular: being *triangular*, with three angles and three flat sides; *trigonous*, with three convex faces; *triquetrous*, with three concave sides; *quadrangular* or square; *quinquangular* or five-angled; *octangular* or eight-angled, &c. Various terms are applied to the forms of stems, as *cylindrical* or *terete*, *jointed* or *articulated*, &c. The following are some of the more important modifications of stems:—The *crown of the root* is a shortened stem, often partially under ground, which remains in some plants after the leaves, branches, and flower-stalks have withered. In this case the internodes are very short, and the nodes are crowded together, so that the plant appears to be stemless. It is seen in perennial plants, the leaves of which die down to the ground annually. A *rhizome* or *root-stock* (fig. 68) is a stem which runs along the surface of the ground, being partially covered by the soil, sending out roots from its lower side and leaf-buds from its upper. It occurs in Ferns, Iris, Hedychium, Acorus or Sweet Flag, Ginger, Water-lily, many species of Carex, Rushes, Anemone, Lathræa, &c. By many the term *rhizome* is applied to stems creeping horizontally, whether they are altogether or only partially subterranean. In rhizomes called definite, the terminal bud gives off flowers, and the lateral buds form the stem; while in indefinite rhizomes the terminal leaf-bud is formed annually. A rhizome such as occurs in Solomon's Seal (fig. 68) is not a single stem, *i.e.*, the product of a single bud, but is composed of portions of successive axes, the leaves of which have died off and remain as scars (fig. 68, *c*, *c*); it is thus an indefinite rhizome. Rhizomes are well seen in British Ferns. A rhizome sometimes assumes an erect form as in Scabiosa succisa, in which the so-called *præmorse* root is in reality a rhizome, with the lower end decaying. The erect rhizome of Cicuta virosa shows hollow internodes, separated by partitions.

Modification of stem

Fig. 68.

Rhizome *r* of *Polygonatum multiflorum* (Solomon's Seal), forming buds and adventitious roots. *a*, young bud; *b*, bud developed as a branch; *c*, *c*, cicatrices or scars of old branches.

A *pseudo-bulb* (fig. 62) is an enlarged bulbous-like aerial stem, common in Orchidaceous plants. It is succulent, often contains numerous spiral cells and vessels, and is covered with a thick epidermis. A *soboles* is a creeping underground stem, sending roots from one part and leaf, buds from another, as in Couch-grass, Carex arenaria, and Scirpus lacustris. It is often called a creeping root, but is really a rhizome with narrow elongated internodes. A *tuber* is a thickened stem or branch produced by the approximation of the nodes and the swelling of the internodes, as in the Potato. The eyes of the Potato are leaf-buds. Tubers are sometimes aerial, occupying the place of branches. The ordinary herbaceous stem of the Potato, when cut into slips and planted, sends off branches from its base, which assume the form of tubers. Tubers frequently store up a quantity of starch as in Maranta arundinacea, whence arrowroot is derived. Another form of thickened underground stem is the *corm*, as seen in the Autumn Crocus (Colchicum, fig. 69), Gladiolus, &c. Structurally it is composed of a solid more or less rounded axis covered by a layer of thin membranous scales (fig. 70, *h*, *h*). A

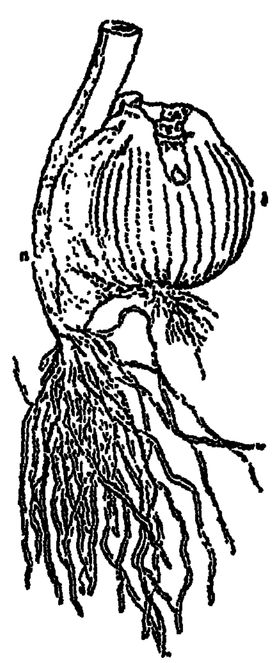


Fig. 69.

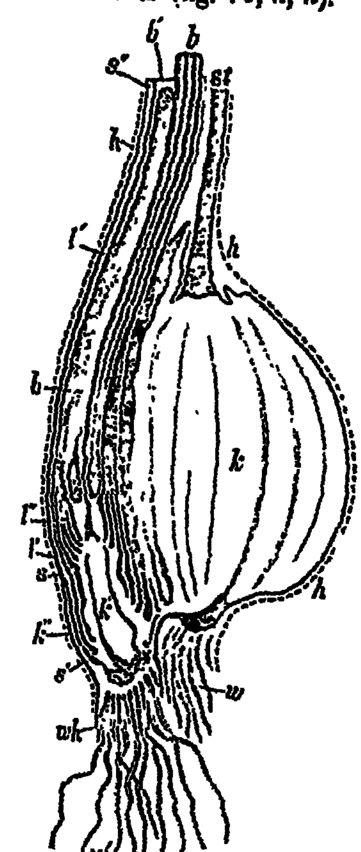


Fig. 70.

Fig. 69.—Corm of Meadow Saffron (*Colchicum autumnale*). *a*, old corm shrivelling; *b*, young corm produced laterally from the old one.

Fig. 70.—Corms of *Colchicum autumnale* in autumn when the plant is in flower. *k*, oldest corm; *h*, *h*, brown scales covering it; *w*, its roots; *st*, its withered flowering stem; *k'*, younger corm produced from *k*; *wk*, roots from *k'*, which grows at expense of *k*; *s*, *s'*, *s''*, sheathing leaves; *l'*, *l''*, foliage leaves; *b*, *b*, flowers; *k''*, young corm produced from *k'* in autumn, and which in succeeding autumn will produce flowers. (*Sachs.*)

corm is only of one year's duration, giving off buds annually in the form of young *corms*. In autumn the young corm gives origin to leaves, the lower of which (*s*, *s'*, *s''*) form sheaths round the corm and flower-stalk, the upper (*l'*, *l''*) remaining very small; and in the axil of the uppermost leaves the flowering-stem develops and bears the flowers (*b*, *b'*). Meanwhile in the axil of the middle leaves on the corm, a bud—the rudiment of a new corm—appears (*k''*). The flowering-stem dies down, and the corm from which it arose enlarges greatly during the winter at the expense of its parent corm (*k*), which thus becomes shrivelled. In spring the leaves produced *on it* (*l'*, *l''*), which were merely rudiments in autumn, appear above ground as conspicuous

large leaves. At the end of spring these leaves die down, the bases of the lower ones alone remaining, and constituting thin brown scales around the corm (as at *h*). Meanwhile, the young bud corm (*k''*) in the axil of the middle leaves grows rapidly at the expense of its parent corm (*k'*), but it does not attain a great size. In autumn it produces new leaves, which remain small, but from the axil of the two upper the flowering stem rises up and bears flowers; whilst in the axil of its middle leaves a new bud-corm appears, which will the following autumn produce young leaves, flowering stem, and a new bud-corm, and thus the cycle goes on. The buds or new corms formed from the old corms may be produced either laterally, as in Colchicum autumnale, or terminally, as in Crocus and Gladiolus. The *bulb* is another form of underground stem or bud. The axis in this case is much shortened, and the internodes are hardly developed. The bases of the leaves rising from the stem are quite close together, and become succulent and enclose the axis. In the Lily the thick and narrow scales are arranged separately in rows, and the bulb is called *scaly;* while in the Leek, Onion, Squill, and Tulip the scales are broad, and enclose each other in a concentric manner, the outer ones being thin and membranous, and the bulb is *tunicated.* In the axils of these fleshy scales new lateral shoots arise, forming new bulbs. The lateral buds or *cloves* sometimes remain attached to the axis, and produce flowering stems, so that apparently the same bulb continues to flower for many years, as in the Hyacinth and Tulip; at other times the young bulbs are detached, and form separate plants. In the axil of the leaves of Lilium bulbiferum, Dentaria bulbifera, and some other plants, small conical or rounded bodies are produced, called *bulbils* or *bulblets* (fig. 71, *b*). They resemble bulbs in their aspect, and consist of a small number of thickened scales enclosing a growing-point. These scales are frequently united closely together, so as to form a solid mass. Bulbils are therefore transformed leaf-buds, which are easily detached, and are capable of producing young plants when placed in favourable circumstances. The scales in bulbs vary in number. In Gagea there is only one scale; in the Tulip and Fritillaria imperialis they vary from two to five; while in Lilies and Hyacinths there are a great number of scales. In the Tulip a bud is formed in the axil of an outer scale, and this gives rise to a new flowering axis, and a new bulb, at the side of which the former bulb is attached in a withered state.

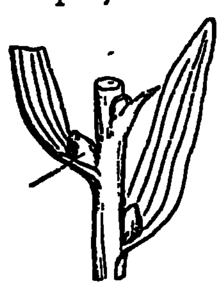


Fig. 71.
Stem of Bulbiferous Lily (*Lilium bulbiferum*), showing bulbils or bulblets *b*, produced in the axils of the leaves.

cture tem. The forms of the stem having been considered, we now proceed to examine its anatomical structure. This structure consists of the elementary tissues combined and arranged in various ways. The arrangement of the fibro-vascular bundles in the mature stem or root is not the same in all plants. But we find that in most plants which have two seed-lobes in the embryo, *i.e.*, Dicotyledons, a characteristic structure is apparent, quite distinct from what is found in the majority of plants in which only one seed-lobe is present in the embryo, *i.e.*, in Monocotyledons; and these, again, have a different structure from that found in Acotyledons, or plants with no seed-lobe in their embryo. The three forms of stem here referred to have been usually distinguished as follows:—(1.) *Exogenous* stem, in which the fibro-vascular bundles are produced indefinitely in an outward direction, and the stem increases in diameter by the annual formation of a new layer of woody matter on the outside of the preceding layers. This is the form found in most Dicotyledons, and they have hence been called *Exogens*, or Outward-growers. Ordinary trees, such as the Oak and Ash, furnish instances. (2.) *Endogenous* stem, in which the fibro-vascular bundles are definite, and are formed towards the centre, which becomes filled up with them in the progress of growth, so that the diameter of the stem increases in a great measure by the new matter pushing out that previously formed. This stem characterizes many Monocotyledons, which have thus been called *Endogens*, or Inward-growers. Palms supply examples. (3.) *Acrogenous* stem, in which the bundles of vessels are simultaneously developed, and the additions to the stem take place at the summit by the union of the bases of the leaves. Plants having this kind of stem are called *Acrogens*, or Summit-growers, and are Acotyledons. Tree-ferns furnish an example. Recent research, however, has shown that these terms cannot always be used as synonymous with Dicotyledon, Monocotyledon, and Acotyledon, as we find amongst Dicotyledons stems where the formation of new fibro-vascular bundles is distinctly endogenous, and again amongst Monocotyledons stems with a provision for exogenous growth, and also amongst Acotyledons examples are not wanting in which a continuous increase in diameter is provided for.

We shall consider the structure of the stem in Dicotyledons, Monocotyledons, and Acotyledons successively.

In the young stem of a Dicotyledon the fibro-vascular bundles first appear as a circle of wedge-shaped masses, by which the stem is divided into a central cellular portion, the *pith*, and a peripheral *cortex*,—the space between the bundles being occupied by cellular tissue constituting the *medullary rays*, and uniting the pith and cortex. Each fibro-vascular bundle increases by division of its own cambium cells. If eventually all the cambium cells become permanent tissue then the bundle becomes closed, and all further growth ceases. This is the complete structure of an annual herbaceous dicotyledonous stem, which thus consists of a central cellular pith, a circle of fibro-vascular bundles, a cellular cortex united with the pith by medullary rays, and outside all an epidermis (fig. 72). In trees and shrubs with permanent woody stems, the young shoots given out annually have a structure similar to that of annual herbaceous stems; but as the shoot grows, further changes occur by which the diameter is increased, and the stem becomes more dense. After the first year's growth, the cells of the medullary rays, stretching between the fibro-vascular bundles and continuous with their cambium cells, become converted into *secondary meristem*, and then an *interfascicular* cambium is formed, which eventually coalesces with the cambium cells of the fibro-vascular bundles, and thus a complete *cambium ring* is formed (fig. 73). From this cambium ring new xylem or wood is formed on the inside, whilst new cortex

Stem Dicoty dons.

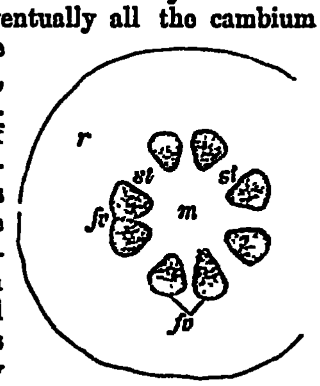


Fig. 72.
Young Dicotyledonous stem. *m*, pith; *fr*, wedge-shaped fibro-vascular bundles; *st*, medullary rays; *r*, cortex. Outside all is the epidermis. (*Sachs.*)

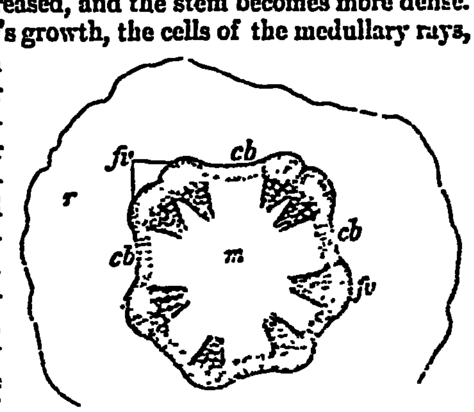


Fig. 73.
Young Dicotyledonous stem. *m*, pith; *fv*, fibro-vascular bundles; *cb*, [illegible] which a cambium ring is formed; *r*, cortex. (*Sachs.*)

is formed on the outside; and in this way the stem increases in thickness. This growth in thickness, however, ceases periodically, and is renewed with each new period of vegetation, and thus the wood is formed in concentric layers, sharply marked off from succeeding layers, each being an *annual ring* of wood, and the same is seen in the cortex (fig. 74). The rings of wood are thus formed successively outside those pre-existing, while in the cortex the new layers are produced inside those already formed.

The inner vessels of the primary fibro-vascular bundles immediately surround the pith and often project into it, and form what is termed the *medullary sheath*, which consists of spiral vessels, and through this sheath the primary medullary rays pass. These medullary rays extend from the pith to the cortex, but as new zones of wood and cortex are produced, new rays are formed in them, which increase by additions from the cambium layer. The secondary cortex, formed from the cambium ring, constitutes what is commonly known as the inner bark or *endophlœum*; the primary cortex, which forms the outer bark, consists of two layers of cells, which have been respectively termed the *mesophlœum* and the *epiphlœum*. Outside all is the epidermis. This, however, does not remain as thin-walled cells, but is usually converted into *periderm*, and this may in turn be completely supplanted by the bark. Thus, if a transverse and a longitudinal section of a Dicotyledonous stem be made, the following structures will be seen as represented in fig. 74. In the centre is the cellular pith *a*, *a*,

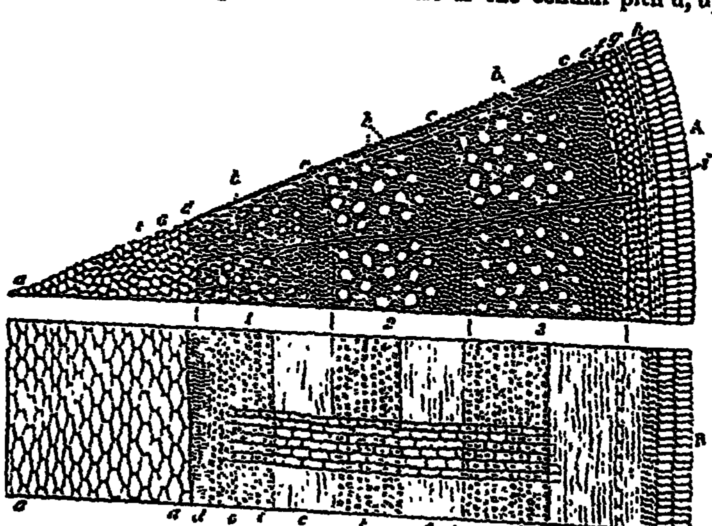


Fig. 74.

Diagram of the structure of an Exogenous or Dicotyledonous stem of three years' growth, A being a transverse section, and B a vertical section. The figures 1, 2, 3, mark the years of growth, and the letters refer to the same parts in both figures. *a*, *a*, medulla or pith, consisting of hexagonal parenchyma; *b*, *b*, *b*, pitted or dotted vessels, and *c*, *c*, *c*, wood-cells, of successive annual layers; *d*, spiral vessels of the medullary sheath; *e*, layer of cambium cells between wood and bark; *f*, inner bast layer of bark (Liber, Endophlœum); *g*, cellular envelope, forming middle layer of bark (Mesophlœum); *h*, outer corky layer of bark (Epiphlœum); *i*, *i*, medullary ray which, in the transverse section, is seen running continuously from the pith to the bark. (*After Carpenter.*)

immediately surrounding it comes the medullary sheath *d*, then the secondary layers of wood *b*, *c*, of successive years' growth, outside this the cambium ring *e*, separating the wood-layers from the cortical layers. Of these last, the inner, *f*, is the bast layer or endophlœum, *g* is the middle cellular layer or mesophlœum, and *d* is the outer epiphlœum. The latter two constitute the outer bark. Connecting the mesophlœum with the pith is seen a medullary ray *i*. Outside all are the epidermal tissues.

Let us now examine the different parts of an Exogenous stem proceeding from the centre to the circumference:—

Pith. The *Pith*, or the central part of a Dicotyledonous stem, is composed of cellular tissue. In the young stem it is succulent, the cells being full of fluid and frequently of a greenish hue; but in process of time it becomes pale-coloured, dry, and full of air. These changes take place first in the central cells. Sometimes the pith is broken up into cavities, which have a regular arrangement, as in the Walnut, Jessamine, and Cecropia peltata; it is then called *discoid* or *disciform*. At other times, by the rapid growth of the outer part of the stem, the pith is ruptured irregularly, and forms large cavities, as in the fistular stem of Umbelliferous plants. Plate VII. In some cases fibro-vascular bundles are found in the pith, as in Elder, Pitcher-plant, and Ferula, and occasionally its cells are marked by pores indicating a thickening of the cell-wall. The extent of pith varies in different plants and in different parts of the same plant. In Ebony it is small, while in the Elder it is large. In Æschynomene aspera (Shola plant, the Rice-paper plant of India), the interior of the stem is almost entirely composed of cellular tissue or pith; from this a kind of paper is made, and light hats. The same kind of tissue occurs in the Papyrus of the Nile. Large pith is also seen in Fatsia (Aralia) papyrifera (Tung-tsaou or Chinese rice-paper plant), and in Scævola Taccada of the Malay archipelago. When the woody circle of the first year is completed, the pith usually *remains stationary* as regards its size, retaining more or less its dimensions, even in old trunks, and never becoming obliterated.

The *Medullary Sheath* is the fibro-vascular layer immediately surrounding the pith. Medullary sheath. It is the inner layer of the fibro-vascular bundle of the first year (fig. 74, *d*), and consists chiefly of true spiral vessels, with annular and reticulated vessels, intermixed with long woody fibres, which continue to exercise their functions during the life of the plant, and which extend into the leaves. Between the vessels of the sheath the medullary rays from the pith pass.

The *Wood*.—The layers of wood (fig. 74, *b*, *c*) are formed The wood. outside the medullary sheath in concentric rings in the manner already described. On account of this mode of formation of wood-layers successively outside pre-existing layers the stem increases indefinitely. There are *no annular* or *spiral* vessels present; these have been replaced by pitted and punctated vessels along with wood-cells. The stems have been called *exogenous* and also *indefinite*, and Dicotyledonous plants have sometimes received the name of *Cyclogens*, in consequence of exhibiting concentric circles in their stems. On a transverse section each zone or circle is usually seen to be separated from that next to it by a well-marked line of demarcation. This line, as in the Oak and in the Ash, is indicated by holes which are the openings of large pitted vessels,—the remainder of the tissue in the circle being formed by pleurenchymatous tubes with thickened walls and of smaller calibre. In some trees, as the Lime, Hornbeam, and Maple, the line is by no means so well marked, as the openings are smaller and more generally diffused; but there is usually a deficiency of pitted vessels towards the outer part of the circle. In cone-bearing plants, as the Fir, in which the woody layers consist entirely of punctated tissue, without any large pitted vessels, the line of separation is marked by the tissue becoming dense and often coloured. In some kinds of wood, as Sumach, the zones are separated by a marked development of cellular tissue. The separation between the zones is owing to the interruption in the growth of the tree during autumn and winter, and hence it is well defined in trees of temperate and cold climates. But even in tropical trees, the lines, although often inconspicuous, are still visible,—the dry season, during which many of them lose their leaves, being their season of repose.

The woody layers vary in their texture at different periods. At first all the tissues are pervious and full of fluid; but by degrees they become thickened, and the channels of the vessels get filled up and obliterated. The first-formed layers are those which soonest become thus

altered. In old trees there is a marked division between the central *heart-wood* or *duramen*, and the external *sap-wood* or *alburnum*,—the former being hard and dense, and often coloured, with its tubes dry and thickened, while the latter is less dense, is of a pale colour, and has its tubes permeable by fluids. The difference of colour between these two kinds of woods is often very marked. In the Ebony tree the duramen or perfect-wood is black, and is the part used for furniture, while the alburnum is pale; in the Beech, the heart-wood is light-brown; in the Oak, deep-brown; in Judas tree, yellow; in Guaiacum, greenish. The alteration in colour is frequent in tropical trees. In trees of temperate climates, called *white-wood*, as the Willow and Poplar, no change in colour takes place; this is also the case in the Chestnut and Bombax. The relative proportion of alburnum and duramen varies in different trees. The heart-wood is more useful than the sap-wood, and is less liable to decay.

From the mode in which the woody layers are formed, it is obvious that each vascular zone is moulded upon that which precedes it; and as, in ordinary cases, each woody circle is completed in the course of one year, it follows that, by counting the concentric circles, the age of a tree may be ascertained. Thus fig. 75 represents an oak eight years old, having eight woody layers *b*. This computation can only be made in trees having marked separations between the circles. There are, however, many sources of mistake. In some instances, by interruption to growth, several circles may be formed in one year, and thus lead to an erroneous estimate. Care must be taken to have a complete section from the bark to the pith, for the circles sometimes vary in diameter at different parts of their course, and a great error might occur from taking only a few rings, or circles, and then estimating for the whole diameter of the tree. When by the action of severe frost, or other causes, injury has been done to the tender cells from which the young wood is developed, while, at the same time, the tree continues to live, so as to form perfect woody layers in subsequent years, the date of the injury may be ascertained by counting the number of layers which intervene between the imperfectly formed circle and the bark. Inscriptions made in the wood become covered, and may be detected in after years when a tree is cut down; so also wires or nails driven into the wood. As the same development of woody layers takes place in the branches as in the stem of an exogenous tree, the time when a branch was first given off may be computed by counting the circles on the stem and branch respectively. If there are fifty circles, for instance, in the trunk, thirty in one branch and ten in another, then the tree must have been twenty years old when it produced the first, and forty when it formed the other.

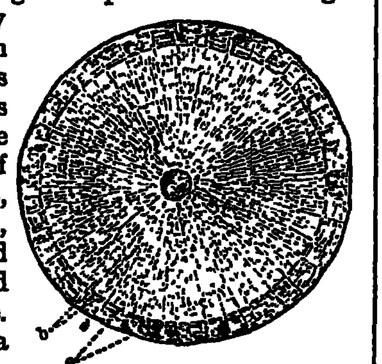


Fig. 75.

Horizontal section of the stem of an oak eight years old. *b*, wood, showing concentric circles or zones, separated by points which correspond to the opening of the large pitted vessels; *e*, bark, showing also eight concentric circles, thinner and less distinct. The wood and bark are traversed by medullary rays, some of which are the primary rays extending from the bark to the pith, while others (the secondary rays) reach only a certain way inwards.

In exogenous stems the pith is not always in the centre. The layers of wood on one side of a tree may be larger than those on the other, in consequence of their fuller exposure to light and air, or the nature of the nourishment conveyed, and thus the pith may become *excentric*. Zones vary in size in different kinds of trees, and at different periods of a plant's life. Soft wooded trees have usually broad zones, and old trees form smaller zones than young ones. There are certain periods of a plant's life when it seems to grow most vigorously, and to form the largest zones. This is said to occur in the Oak between twenty and thirty years of age.

Cambium.—External to the layers of wood, and between them and the bark, there is a layer of thin-walled cells in which the protoplasm and cell-sap remain, and consequently they are capable of division and growth. To this layer the name of *cambium* has been given. This cambium layer marks the separation between the wood and the bark, and may be regarded as constituting the active formative tissue of Dicotyledonous stems. It constitutes the *thickening zone*, by means of which the stem is enlarged,—the cambium cells situated most internally being subservient to the purposes of the wood formation, while the external ones give origin to the new bark. When these cells are carrying on the process of growth with activity, during the flow of the sap in spring, the bark can be easily separated from the wood. Cambium

The *Bark* or *Cortical System* lies external to the wood, and, like it, consists of several layers. In the early state it is entirely cellular, and is in every respect similar to the pith; but as the fibro-vascular bundles are developed, the bark and pith are separated, and the former gradually becomes altered by the formation of secondary deposits. We find in the cortex, as in the wood portion of the stem, fibro-vascular along with cellular tissue. But the position and relative proportion of these two systems is reversed. In the bark the cellular system is external, and is much developed, while the fibro-vascular is internal, and occupies comparatively a small space. The cellular portion of the bark consists of an external layer, or *epiphlœum*, and the cellular envelope, or *mesophlœum*, while the vascular system forms the internal portion called *liber*, or *endophlœum*. The bark.

The *endophlœum*, liber, or inner bark, is formed from the secondary cortex of the young stem. It consists mainly of thick or thin walled woody fibres, commonly known as bast-fibres, mixed with elongated cellular tissue and frequently with laticiferous vessels. It is separated from the wood by the cambium layer. The pleurenchymatous tubes are thickened so as to be flexible, but are not lignified, and are thus very tenacious. The endophlœum of the Lime-tree and of Antiaris saccidora (the Sack tree of Coorg) is used to form mats, cordage, and bags; and the toughness of the fibres of the inner bark of flax, hemp, and of many of the Nettle and Mallow tribes, render them fit for various manufacturing purposes. The endophlœum is sometimes, from its uses, called the *bast-layer*. Occasionally it is continuous and uninterrupted, as in the Vine and Horse-chestnut; at other times, as in the Oak, Ash, and Lime, the fibres are separated during the progress of growth, and form a sort of network, in the interstices of which the medullary rays are seen. The fibres of the Lace-bark tree (Lagetta lintearia) are similar. In fig. 76 is represented the bark of Daphne Laureola,—*f* indicating the woody fibres of liber, and *r* the medullary rays. The endophlœum increases by layers on its inside, which are thin, and may be separated like the leaves of a book. The outer layer of bast-fibres betwixt the endophlœum and the outer bark has been termed the *cortical sheath*, corresponding to the medullary sheath on the inside of the stem.

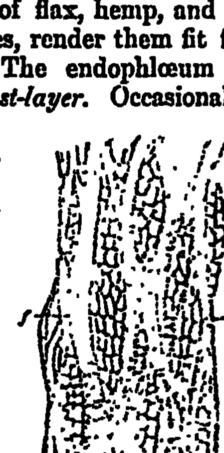


Fig. 76.

Network formed by liber of *Daphne Laureola*. *f. f.* [illegible]; *r. r.* medullary rays.

The outer bark is formed from the primary cortex; it is always cellular, and is divided into two layers, the epi-

phlœum with the mesophlœum underneath. The cellular envelope, or *mesophlœum*, lies immediately on the outside of the liber. It consists of polyhedral, often prismatical cells, elongated vertically to the surface, usually having chlorophyll, or green colouring matter, in their interior, but sometimes being colourless, and containing raphides. They are distinguished from those of the epiphlœum by their *form* and direction, by their thicker walls, their green colour, and the intercellular spaces which occur among them. This covering is usually less developed than the outer suberous layer, but sometimes, as in the Larch and common Fir, it becomes very thick, and separates like the epiphlœum. In the cellular envelope laticiferous vessels occur. The *epiphlœum* is the outer covering of the bark, consisting of cells which usually assume a cubical or flattened tabular form. The cells have no chlorophyll in their interior, are placed close together, and are elongated in a horizontal direction; and thus they are distinguished from the cells of mesophlœum. In the progress of growth they become often of a brown colour. This covering may be composed of a single layer of tabular cells; but in some trees it consists of numerous layers, forming the substance called *cork*, which is well seen in Quercus Suber, the Cork-oak; hence the name *suberous*, or *corky layer*, which is given to it. The form of its cells varies in some instances, being cubical at one part, and more compressed or tabular at another, thus giving rise to the appearance of separate layers. On the exterior of the epiphlœum is situated the epidermis, which has already been described. It is formed of a layer of cells, which in woody stems serve only a temporary purpose, becoming ultimately transformed in various ways.

The bark, in its increase, follows an order exactly the reverse of that which occurs in the woody layers. The layers of liber owe their increase to the cambium cells, which, by their constant reproduction, mark the separation between the xylem and phloëm portions of the stem. These layers are often so compressed and united together as to be counted with difficulty, while at other times they are separated by rings of cellular tissue, and thus remain conspicuous. As the additions are made to the woody layers on the outside, and to the bark on the inside, there is a constant distension going on, by which the bark becomes compressed, its layers of liber are condensed, the fibres are often separated (fig. 76) so as to form meshes, its epidermis is thrown off, and the epiphlœum is either detached along with it, or, when thick, is ruptured in various ways, so as to give rise to the rugged appearance presented by such trees as Elm and Cork-oak. In some instances the bark is very distensible, and its outer cellular covering is not much developed, so that the surface remains smooth, as in the Beech. The outer suberous layer sometimes separates with the epidermis, in thin plates or scales; in the Birch these have a white and silvery aspect. There is thus a continual destruction and separation of different portions of the bark. The cellular envelope and liber may remain while the epiphlœum separates, or they also may be gradually pushed off—the parts which were at first internal becoming external. In the case of some Australian trees both the cellular and fibrous portions are detached in the form of thin flakes, and occasionally each annual layer of liber pushes off that which preceded it. The epidermis separates early, and no renewal of it takes place. It *is*, however, replaced by the cork layer, which then covers the outer part of the stem. To this covering the name *periderm* is given.

From the mode in which the outer layers of bark separate, it follows that inscriptions made on them, and not extending to the wood, *gradually fall* off and disappear. A nail driven into these layers ultimately falls out. In consequence of the continued distension of an exogenous stem, it is found that woody twining plants cause injury, by interrupting the passage of the fluids. Thus a spiral groove may be formed on the surface of the stem by the compression exercised by a twining plant, such as Bush-rope (Bauhinia, fig. 77) or Honeysuckle. From what has been stated relative to the changes which take place in the bark, it will be understood that it is often difficult to count its annual layers, so as to estimate the age of the tree by means of them. This may, however, be done in some cases, as shown at fig. 75, where there are eight layers of bark *e*, and eight woody layers *b*.

Medullary rays.

Fig. 77.

Stem of an Exogenous tree, surrounded by a woody climber called Bush-rope.

Medullary Rays or Plates.—While the bark and pith become gradually separated by the intervention of vascular bundles, the connection between them is kept up by means of processes called *medullary rays* (figs. 78 and 79). These form the *silver grain* in wood, so conspicuous in the maple; they communicate with the pith and the cellular envelope of the bark, and they consist of cellular tissue, which becomes compressed and flattened so as to assume a muriform appearance. At first they occupy a large space (fig. 72, *st*); but as the vascular bundles increase they become more and more narrow, forming thin laminæ or plates, which separate the woody bundles. On making a transverse or horizontal section of a woody stem, the medullary rays present the aspect of narrow lines running from the centre to the circumference (fig. 74); and on making a vertical section of a similar stem through one of the rays, the appearance represented in fig. 78 will be observed, where a medullary ray *mr*, composed of flattened muriform cells, passes from the pith *p* to the cellular

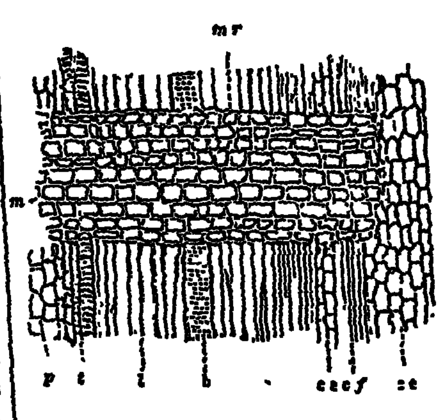


Fig. 78.

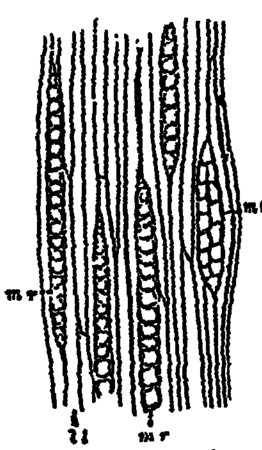


Fig. 79.

FIG. 78.—Vertical section of a young Dicotyledonous stem, parallel to the medullary rays.
FIG. 79.—Vertical section of the same, tangential to the medullary rays.

envelope *ce*, crossing the tracheæ of the medullary sheath *t*, the ligneous tissue *l*, the pitted vessels of the wood *b*, and the fibres of the liber *cf*. The laminæ do not by any means preserve an uninterrupted course from the apex to the base of the tree. They are broken up by the intervention of woody fibres, as seen in a vertical section of a woody stem (fig. 79), tangentially to the medullary rays *mr*, *mr*, *mr*, which are separated by interlacing fibres *ll*. The primary medullary rays extend completely from the pith to the bark; but in the secondary wood and secondary cortex new rays are formed which, therefore, extend only through a portion of the stem. These are secondary medullary rays. All may increase by division of the merismatic cells of the cambium. Medullary rays are conspicuous in the Cork-Oak, Hazel, Beech, Ivy, Clematis, Vine. They are not so well marked in the Lime, Chestnut, Birch, Yew,

The medullary rays are in some cases, as in Clematis and Aristolochia, large and broad, while the woody wedges are comparatively small.

The stems of Dicotyledonous plants occasionally present anomalous appearances in the structure and arrangement of their wood, bark, and medullary rays. In place of concentric circles there are sometimes only a few rows of wedge-shaped vascular bundles produced during the life of the plant, additions being made by the annual interposition of bundles of a similar kind, resembling in this respect the formation of woody bundles in the early growth of herbaceous plants. In Piperaceæ, Aristolochiaceæ, and Menispermaceæ, these anomalous stems occur. In Gnetum (fig. 80), the vascular bundles, *b, b, b, b, b*, form zones, which

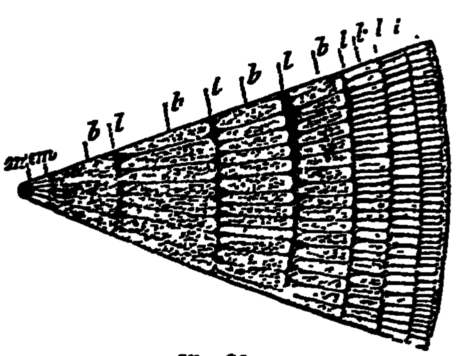


Fig. 80.

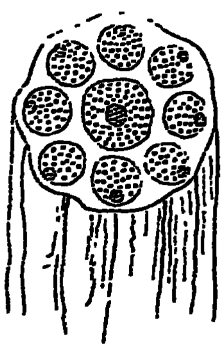


Fig. 81.

FIG. 80.—Horizontal section of stem of Gnetum. *m*, pith; *em*, medullary sheath; *b, b, b, b, b*, woody bundles forming seven concentric zones, each of which is the produce of several years; *l, l, l, l, l, l*, fibres of liber, forming interposed circles equal in number to the woody zones.

FIG. 81.—Peculiar stem of a Malpighiaceous plant of South America. The plant is Dicotyledonous.

are each the produce of several years' growth, and are separated by layers, *l, l, l, l, l, l*, which may be considered as representing different bast-layers. In some of the Menispermaceæ the separating layers are of a cellular and not of a fibrous nature. Many of the Malpighiaceæ, Sapindaceæ, and Bignoniaceæ of Brazil exhibit stems in which the woody layers are arranged in a very irregular manner. In some of them (fig. 81) there is a central woody mass with from three to ten small secondary ones round it. Each of the masses contains true pith, derived either from the cortical cellular tissue, or from the original medullary centre. Around these separate collections of pith there is a medullary sheath and spiral vessels. No annual rings have been detected in the secondary masses, but medullary rays exist usually in their outer portion. In some anomalous Sapindaceæ, the central and lateral woody masses are enclosed in a common bark, with a continuous layer of liber. Some have supposed that the lateral masses are undeveloped branches united together under the bark.

In some Bignoniaceæ (fig. 82) the layers of wood are divided

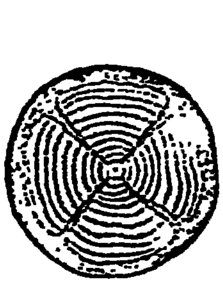


Fig. 82.

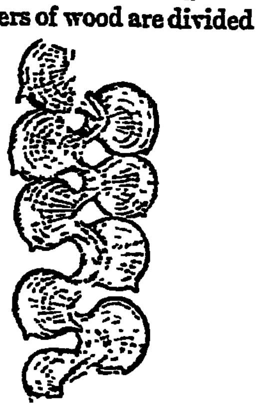


Fig. 83.

FIG. 82.—Horizontal section of the stem of *Bignonia capreolata*, showing the crucial division of the woody layers.

FIG. 83.—Fragment of a stem of a climbing species of Banisteria (*B. scandens*), showing the effects of compression.

in a crucial manner into four wedge-shaped portions by the intervention of plates differing in texture from the ordinary wood of the plant, and probably formed by the introversion, or growing inwards, of the liber. In Aspidosperma excelsum (Paddle-wood) of Guiana, and in Heteropterys anomala, the stem assumes a peculiar lobed and sinuous aspect; and in some woody climbing plants pressure causes the stems to become flattened on the side next the tree on which they are supported, while from being twisted alternately in different directions, they present a remarkable zigzag form, having the woody layers developed only on one side (fig. 83). In Firs the wood is occasionally produced in an oblique in place of a perpendicular manner, thus injuring the timber and causing it to split in an unusual way. The young plants produced from the seed of such twisted-wooded firs are said to inherit the peculiarity of their parents. Occasionally the Dicotyledonous stem becomes swollen at certain places, especially near the root, and thus exhibits a tuberous appearance. This peculiarity is said to be liable to occur in Coniferous plants grown from cuttings. In some of the lower class of plants a cellular stalk is produced, which on a transverse section presents an appearance like that of a Dicotyledonous stem. Thus Lessonia fuscescens, a species of sea-weed, has stems which are often 5 to 10 feet long, and as thick as the human thigh, and which show concentric elliptic cellular rings. Such is also the case with Usnea melaxantha, a tree-like lichen. In these plants, however, the structure is entirely cellular, and quite distinct from that of Dicotyledonous plants.

Stem in Monocotyledons.

In the young stem of a Monocotyledonous plant the fibro-vascular bundles appear scattered in an irregular manner through the fundamental parenchyma, becoming more numerous towards the periphery. There is thus no primary separation in the stem into pith, cortex, and medullary rays, although the central cellular mass may be considered as representing the pith. Thus, if a section be made across a young Monocotyledonous stem, an appearance is observed such as is represented in fig. 84, where the vessels are seen

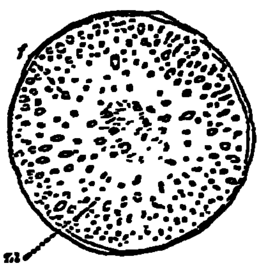


Fig. 84.

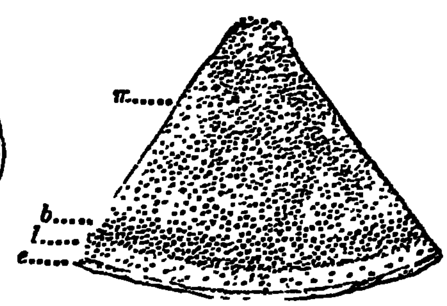


Fig. 85.

FIG. 84.—Transverse section of the stem of a Palm, which is Monocotyledonous. *m*, the central loose cellular portion; *f*, the outer fibrous portion, showing numerous vascular bundles. The whole being covered by a false bark or rind.

FIG. 85.—Transverse section of the stem of a Palm, more advanced.

as points scattered through a cellular matrix, the circumference not having any marked cortex, and the whole covered by an epidermis. A similar section of a further advanced stem, as of a Palm (fig. 85), shows numerous bundles of vessels dispersed irregularly in cellular tissue; those near the centre, *m*, being scattered at a distance from each other, while those towards the outside are densely aggregated, forming a darkish zone *b*, and are succeeded at the circumference by a paler circle of less compact vessels *l*, with some compressed cells, covered by an epidermis *e*. The central cellular mass has no medullary sheath. In some cases its cells are ruptured, and disappear during the progress of growth, leaving a hollow cavity; but in general it remains permanent, and is gradually encroached upon by the development of the vascular system. The peripheral portion differs from *true* bark in not being separable from the rest of the tissue. It has received the name of *false* bark, and consists of the epidermal cells *e*, and what has been called the cortical integument, *l*. This

portion of the stem is often very inconspicuous, but sometimes it is much developed, as in Testudinaria Elephantipes, in which it is rugged, and is formed of a substance resembling cork in many respects. The fibro-vascular bundles of the stem very soon become closed, and thus all growth in them ceases, the cambium cells being converted completely into permanent tissue. Fig. 57 represents a transverse section of a closed fibro-vascular bundle from the stem of the maize (Zea Mays). In it the several elements seen in the section of the fibro-vascular bundle from a Dicotyledonous stem may be recognized, but there is no cambium, the cells marked *v*, *v* representing those cambiform cells which have last become permanent tissue. This absence of cambium necessarily curtails the growth of the bundle, and hence the limited diameter characteristic of the stems of Monocotyledons. In fig. 86 a diagram

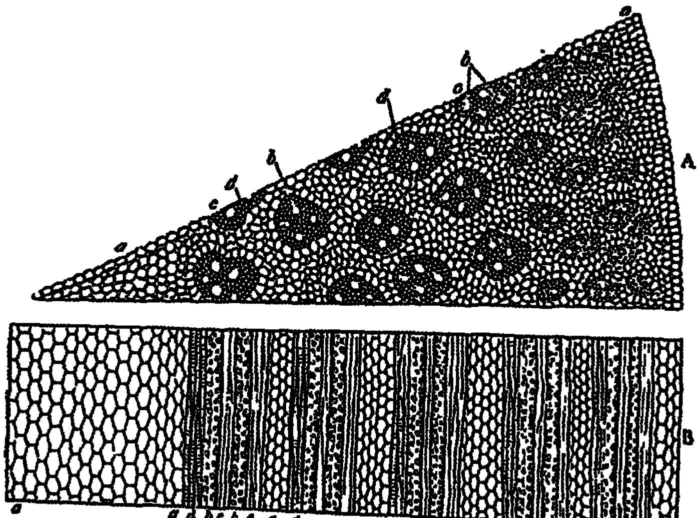


Fig. 86.

Diagram of a Monocotyledonous stem. A, transverse section; B, longitudinal section; *a*, *a*, cellular tissue (Parenchyma); *b*, *b*, dotted vessels (Bothrenchyma); *c*, *c*, woody fibres (Pleurenchyma); *d*, *d*, spiral vessels (Trachenchyma). (*After Carpenter.*)

represents a transverse and longitudinal section of a Monocotyledonous stem.

All the fibro-vascular bundles of the stem are *common* bundles, that is, they pass out into the leaf, and in these stems each bundle has a definite arrangement. At the point where the bundle curves out into the leaf it has its greatest thickness, gradually becoming attenuated as it passes upwards into the leaf and downwards into the stem. In some instances, however, the bundles as they descend increase at different parts of their course, probably by *interstitial* growth, and give rise to irregular swellings of the stem, as in Ceroxylon Andicola. The distension takes place occasionally at the base of the stem, as in Euterpe montana. This downward prolonged portion does not, however, run a straight course, but first passing inwards towards the centre of the stem, it then gradually arches outwards towards the periphery. This passing inwards at first of the fibro-vascular bundle gave origin to the idea that the first formed fibres were gradually pushed towards the circumference by those which succeeded them, and that the wood portion of these stems was increased by additions to the centre; hence the term endogenous applied to them, meaning internal growth. But, as has been shown, the fibro-vascular bundles really become external at the base, although internal above. On making a vertical section of the endogenous stem, as of a Palm (fig. 87), there is observed an interlacing of fibres, the fibro-vascular bundles are first directed towards the centre, and then curve outwards towards the circumference, so that those last formed ultimately become external. The term endogenous will, therefore, only apply strictly to the fibres at the early part of their course. The true distinction between exogenous and endogenous stems is, that in the former the fibro-vascular bundles remain open, a cambium ring being eventually formed from which the stem increases indefinitely in diameter. In the latter the fibro-vascular bundles soon become closed, and being scattered irregularly through the cellular tissue, and not in a circle, no cambium ring can be formed, and thus growth in a transverse direction is soon arrested, and the stem is of a comparatively uniform diameter throughout. The investing bark of the former permits an unlimited extension of woody growth beneath it; the fibrous cortical layer of the latter, by maintaining an intimate union with the subjacent tissue, prevents unlimited increase in diameter. Hence we find that the stem does not attain the enormous diameter exhibited by some Dicotyledonous trees, such as Sequoia (*Wellingtonia*) gigantea and the Baobab,—the former of which has been measured 116 feet in circumference. In consequence of this mode of formation, the outer part of a Palm-stem is the hardest and densest, and after acquiring a certain degree of firmness it resists all further distension, and frequently becomes so hard as to withstand the blow of a hatchet, and therefore a woody twining plant does less injury to it than to trees of exogenous growth (fig. 88). The growth

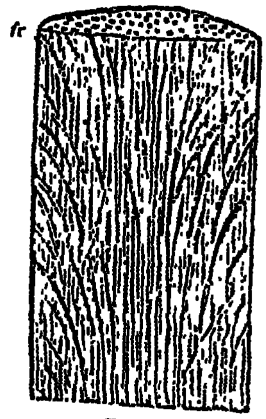


Fig. 87.

Fig. 88.

FIG. 87.—Vertical section of a Palm-stem, showing the vascular bundles, *fr*, curving downwards and interlacing.
FIG. 88.—Monocotyledonous stem, surrounded by a twining woody plant, and remaining uninjured.

of endogenous stems may be said to resemble an upward growth of an exogen by the terminal bud only, for there is no cambium layer, and no peripherical increase. The terminal central bud is called a *phyllophor* or *phyllogen*. As growth only proceeds in this manner, no annual rings of wood are formed. From the absence of concentric circles the age of a Palm cannot be estimated in the same way as that of an exogenous tree. The elongation, however, of each species of Palm is pretty regular, and by this some idea may be formed of its age. There are many herbaceous plants in Britain, as Lilies, Grasses, &c., having Monocotyledonous stems, but there are no British Monocotyledonous plants with permanent aerial woody stems. All the British trees are Dicotyledonous. Illustrations of Monocotyledonous stems must be taken from trees of other countries, and of these Palms furnish the best examples.

Although this limited growth in a transverse direction is characteristic of most Monocotyledons, we find instances where a true thickening ring is formed and an indefinite increase in diameter takes place, as in Dracæna, Yucca, &c. This thickening ring, however, originates in a manner different from that in Dicotyledonous plants. A layer of the fundamental cellular tissue parallel to the surface of the stem becomes merismatic, and produces new closed fibro-vascular bundles and new cellular tissue

between them. The new woody tissue so formed thus corresponds to the secondary wood in Dicotyledonous stems, and the new fibro-vascular bundles are all cauline, that is, do not pass out into the leaves. By this means an enormous increase in diameter of the stem may take place. And not unfrequently the primary central portion of the stem gives way, and thus a hollow cylinder formed by this secondary wood remains. This was well seen in the famous Dracæna Draco, or Dragon tree of Orotava, in the Canary Islands, which had a hollow stem capable of holding several men.

The composition of the vascular bundles in different parts of their course varies. Thus, at the upper part, tracing them from the leaves towards the centre, they contain spiral vessels, pitted vessels with some cellular tissue, a few laticiferous vessels, and woody fibres resembling those of liber. As we descend to the older portions of the bundle, where the tissues have become permanent throughout, the spiral vessels disappear, then the pitted vessels, and at the periphery nothing but pleurenchymatous tissue remains, forming a complicated anastomosis or network. Not unfrequently at the nodes of the stem a network of horizontal vessels occurs. They are well seen in many Grasses, where the central portion of the stem has given way, and there they serve to strengthen the stem. The branching of Monocotyledonous stems is originally the same as in Dicotyledons, namely, a monopodial form; frequently however, the axillary buds do not unfold, and the form becomes much varied. In Palms this is well seen, and usually no lateral shoots are formed. In some Palms, however, as the Doum Palm of Egypt (*Hyphæne thebaica*), the lateral shoots are developed in such a way that the stem appears to fork. Other examples of the development of branches are seen in the case of the Screw-pine (*Pandanus*), in Grasses, as the Bamboo, in Asparagus, Cordyline, Dracæna, &c. In some instances the axillary shoots detach themselves from the parent stem and form an independent plant, as in Lilium bulbiferum (fig. 71). The bases of the leaves produced from the stem remain attached to the stem in many Palms, being surrounded by a fibrous substance, the *mattulla or reticulum.*

When the internodes of the caudex of a Palm are not much elongated, the scars of the leaves are seen forming spirals on the stem, as in the Coco-nut and Date. In Xanthorrhœa Hastile the same arrangement is observed. In this plant also a curious internal structure of the stem occurs. On making a vertical section the structure appears to be that of a Dicotyledon. The woody part is formed of vertical loose fibres as in Palms, and there are other fibres, radiating from the centre, and cutting the preceding at right angles. These horizontal fibres resemble the medullary rays, but differ in their structure. They probably serve for the origin of leaves, which are numerous, and are disposed throughout the whole length of the stem. In Palms, such as species of Chamædorea, the internodes are much lengthened, and rings are seen on the stem at distant intervals, showing thickened node-like joints. Some Palm stems, as those of Calamus Rudentum, the common Cane, are very thin and slender. In many Monocotyledonous plants the stem remains below ground, developing shoots which are simple, as in Banana and Plantain, or branched, as in Asparagus. In the former the stem above ground is an herbaceous shoot, composed of the sheaths of the leaves. It dies after fruiting, and is succeeded by other shoots from the subterranean stem. The shoots or buds from such stems occasionally remain in part below ground in the form of bulbs, as in Lilies, Tulips, and Hyacinths; or as corms, as in Colchicum, Crocus, Gladiolus, and Arum. In some instances the aerial stem has the usual Monocotyledonous structure, while in the underground stem the fibro-vascular bundles are arranged in a circle, enclosing a central cellular mass or pith, and thus resembling in structure a Dicotyledonous stem. This structure has been remarked in the Smilax or Sarsaparilla family. Lindley calls these plants *Dictyogens*, from their netted leaves, by which they differ from most Monocotyledons.

ate XVI. . 2.

Stem in Acotyledons.

Amongst Acotyledonous plants there are some which possess stems consisting entirely of cellular tissue, whilst in others the stems have a well-developed vascular system. Of the former we have examples in Mosses, Hepaticæ, and Characeæ; the latter we find represented in Ferns, Equisetaceæ, and Lycopodiaceæ. The term *Acrogenous* has been used as descriptive of the stems of Acotyledonous plants, as they were supposed to be formed by additions to the summit, and by the elongation of vessels already formed. They are also sometimes called *Acrobrya*. But as in the case of the terms exogenous and endogenous applied to the stems of Dicotyledons and Monocotyledons respectively, recent research has shown that the term acrogenous cannot have the significance formerly attached to it; for in some Acotyledonous plants a true cambium ring is formed by which layers of tissue are successively added, and the stem increases in diameter, and also in many instances the fibro-vascular bundles develop from above downwards. The characters of the stem, however, enable us easily to distinguish it from that in Dicotyledons or Monocotyledons. With merely a slight exception there is no provision for lateral growth of the stem, and all increase in size takes place by an elongation of the terminal growing-point. No cambium ring is as a rule formed; where it does exist, it is not produced in the same way as in Dicotyledons, but rather resembles the formation of the cambium ring in Dracæna amongst Monocotyledons. When a permanent woody stem occurs amongst Acotyledonous plants it resembles in general aspect the stem of a Monocotyledonous plant, having nearly a uniform height, and being usually unbranched and producing a tuft of leaves (fronds) at the summit. Tree-ferns furnish the best example of this kind of stem. In them it is denominated a *stipe*, and it often attains the height of 120 feet. The stem in Acotyledonous plants is distinguished from that in Dicotyledons by the absence of annual rings of wood, of (with only slight exception) a cambium ring, of a separable bark, and by the fact that the fibro-vascular bundles are all closed; in this latter character they agree with Monocotyledons, but are distinguished from them by the arrangement of the vascular bundles.

In Acotyledonous stems growth takes place by division of a single apical cell, situated at the extreme end of the punctum vegetationis. By divisions of this cell two portions of tissue are marked out in the stem,—an inner portion, from which arise the fibro-vascular tissues when they exist, and an outer or cortical portion. The primary fibro-vascular bundles originate from the cellular tissue of the stem in a manner analogous to what occurs in Dicotyledons and Monocotyledons,—a procambial bundle being first formed, which differentiates subsequently into xylem and phloëm layers, but the bundles always become closed. The character of the stem varies very much in the several families of Acotyledonous plants.

Characeæ.

In Characeæ the stem consists of a series of joints (internodes), each composed of a single much elongated cell. Interposed between successive internodes are the nodes, each composed of a whorl of small cells, from which the leaves are developed, one leaf from every cell of the node. In the genus Chara a cortex is found completely investing the internodal cell. It is formed by the development, from every cell, of the nodes of an ascending and descending lobe. The ascending lobes of one node and the descending lobes of the next higher node meet in the middle of the intervening internode, and there interlock in

a prosenchymatous manner. Subsequently by cell-division a complicated structure is developed in this investing mass. No fibro-vascular bundles are found in Characeæ.

Mosses. In Mosses and many Hepaticæ we find no fibro-vascular system, but a slender leafy cellular stem. In it there is sometimes a differentiation into an inner and a peripheral mass of tissue. In the former the cells have usually thin walls, and are not coloured, though in some cases a thickening of the walls of the central cells is observed, and a sort of rudimentary bundle is formed. The circumferential cells have usually thickened walls, and are not unfrequently coloured.

Ferns. In Ferns we have a familiar example of an Acotyledonous stem. Ordinary ferns of Britain seldom attain any height, but usually creep along the ground, forming rhizomes. But in the Tree-ferns of warm climates the caudex frequently attains a great height. A transverse section of the stem of a fern (fig. 89) exhibits an irregular circle of fibro-vascular bundles, composed of masses *f*, *v*, of various forms and sizes, situated near the circumference,—the centre *m* being formed of cellular tissue, frequently with solitary fibro-vascular bundles scattered through it, and often becoming hollow. On the outside of the vascular circle cells exist, *p*, covered by an epidermal layer or cellular integument *e*, often of hard and dense consistence, and marked with the scars of the fronds.

The vascular system is of greater density than the rest of the tissue, and is distinguished by the dark colour of the outer portion (fig. 89, *f*), which surrounds the paler

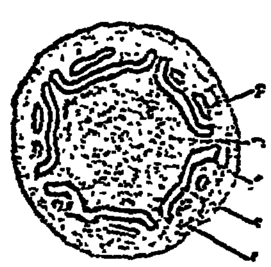


Fig. 90.

constitutes the inner, lighter-coloured portion of the bundles. The phloëm portion, which completely surrounds the bundle, has also starch-cells, and, in addition, sieve-tubes and elongated bast-like thick-walled fibres are found at the periphery of the bundle. The whole bundle is usually enclosed by a distinct sheath of elongated cells; these cells are frequently much thickened and of a dark brown colour, hence the appearance presented on transverse section of a dark layer enclosing a lighter-coloured part. The central cellular portion of the stem frequently becomes ruptured and absorbed in old stems, which are thus hollow. The bases of the leaves remain long attached, but ultimately fall off, leaving marked scars (fig. 91, *c*), which are at first

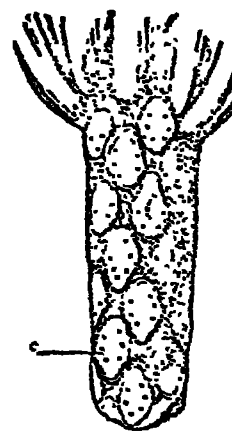


Fig. 91.

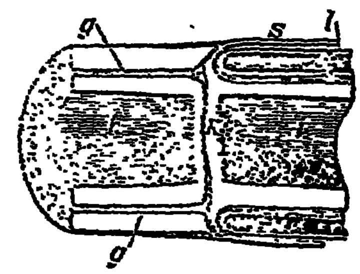


Fig. 92.

FIG. 91.—Rhizome of Male Fern, *Lastrea (Aspidium) Filix-mas*, showing the scars (cicatrices) of the leaves (fronds), with the markings of the vascular bundles, *c*.
FIG. 92.—Longitudinal section of rhizome of Equisetum, showing septum, *k*, between cavities *h*, *h*; *g*, *g*, fibro-vascular bundles; *l*, vallecular canal; *s*, leaf-sheath. (*Sachs*.)

close together, but often separate afterwards by interstitial growth. On these scars or *cicatrices* the markings of the vessels are easily seen, arranged in the same manner as those of the stem. From all points of the woody cylinder stem-roots may be given off, and frequently they are formed so abundantly as completely to invest the stem and conceal it.

In Equisetaceæ or Horsetails we have another example of an Acotyledonous stem. The true stem in those plants is a rhizome underground, from which aerial shoots are sent up annually. Every aerial stem consists of a series of joints (internodes), which are usually hollow and closed at their base by a thin septum (fig. 92). Each internode passes up into a leaf-sheath embracing the next internode, and this sheath is usually split into teeth at its upper margin. In transverse section a circle of fibro-vascular bundles is seen (fig. 93) marking off an inner medullary from an outer cortical portion, and separated one from the other by a mass of parenchyma. These bundles are all common bundles. From each tooth of the leaf-sheath the bundle may be traced, passing vertically down into the internodes In Equisetaceæ.

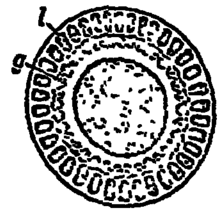


Fig. 93.

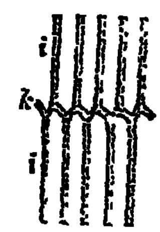


Fig. 94.

FIG. 93.—Transverse section of a rhizome of Equisetum. *g*, fibro-vascular bundles; *l*, vallecular canal; *h*, central cavity. (*Sachs*.)
FIG. 94.—To show union of the fibro-vascular bundle of an upper with a lower internode; *i*, *i*, internode; *k*, node. (*Sachs*.)

as far as the node beneath, and at the lower end dividing into two, uniting by each branch with a bundle of the next lowest internode (fig. 94). In transverse section the bundle

resembles much that of a Monocotyledon. One peculiarity, however, must be noticed. The spiral, annular, and reticulated vessels at the inner side of the bundle soon disappear, and an air-canal is formed in the bundle. This canal must be distinguished from the *vallecular* canals found in the cortex, with which they alternate. Round the bundles a single layer of usually thickened and coloured cells forms a sheath, and this may either run continuously round the stem, and thus shut off completely the medullary from the cortical portion of the stem, or may invest separately each bundle, in which case the medullary and cortical portions of the stem are continuous. In some cases a layer of thickened cells is found within the vascular bundles. The cortical portion is divisible into two layers, an inner layer of parenchymatous cells with air canals, the *vallecular* canals, and an outer layer of thickened cells immediately underlying the epidermis. The structure of the rhizome resembles that of the aerial stem, differing only in the fact that the thickened cells of the outer cortical layer are dark coloured, and that the central canal of the internodes is often absent. In Calamites, a fossil plant which flourished abundantly during the Carboniferous Period, we have a plant which in all particulars is closely allied to Equisetum of the present day. But whilst the young stem of Calamites presented a zone of vascular bundles separating it into a medullary and cortical portion (just as in an Equisetum), new vessels were added to the exterior of the pre-existing bundles as the plant grew, so that a series of woody wedges were formed, increasing in growth to an enormous extent.

ypo- eæ. In Lycopodiaceæ, or Club Mosses, the stem presents differences from that in Ferns and Equisetaceæ. In most members of the family there is an axial cylinder formed of either one or more fibro-vascular bundles. In some cases (Selaginella) the fibro-vascular bundles remain separate and do not form a cylinder. They are surrounded by a mass of prosenchymatous cellular tissue, the cells of which may be thin-walled, leaving no intercellular spaces, or the cell-walls may be much thickened. Immediately surrounding the central axial bundle in Selaginella are large air lacunæ, which are wanting in Lycopodium. The fibro-vascular bundles consist of tissues very similar to what occurs in Ferns, and the bundles are all cauline. In the leaves, bundles arise which pass into the stem and coalesce with the cauline bundles. In Isoetes we find a most anomalous structure. Here there are no internodes in the stem; consequently, it is much shortened. The central axial fibro-vascular bundle is very poorly developed, and round it a meristem is formed, which, by adding new parenchyma outside, increases the diameter of the stem. Thus we have here a thickening ring, but it differs from that structure in Dicotyledons, inasmuch as it is not formed by a union of cambium cells of the fibro-vascular bundles. It resembles more the thickening ring formed in Dracæna, Yucca, and other Monocotyledons.

zo- peæ. In Rhizocarpeæ the structure of the stem is very simple, consisting of an axial fibro-vascular bundle surrounded by parenchyma full of air-cavities.

In plants with Acotyledonous stems the mode of branching is various. In Lycopodiaceæ we have an example of a dichotomous branching, and the same is also seen in Ferns. In the Equisetaceæ a mode of branching occurs seen nowhere else in the Vegetable Kingdom. The branches arise from deeply-seated lateral buds, which, upon developing, break through the superincumbent tissue; these have been termed *endogenous* buds. In Characeæ the branching is of the normal monopodial type.

allogens. Amongst Thallogens, as a rule, there is no evident distinction between stem and leaf. The vegetative organs consist of a number of cells separate or combined into a more or less flattened expansion termed the thallus. In this group are included all the Algæ, Fungi, and Lichens, and many Hepaticæ. The vegetative structures vary much in each of these groups. In many Hepaticæ, as Marchantia, the vegetative structure is of a thalloid nature, and appears as a flattened, broad, dichotomously-branched plate, composed of several layers of cells. The upper and lower layers consist of colourless cells, and form a sort of epidermis. The upper epidermal layer has stomata, while the lower gives off root-like filaments, which attach it to the stratum on which it grows. The stomata are, by repeated division of the guard-cells, converted into canals. The central layer of cells contains green matter, and between the cellules there are large intercellular spaces, which communicate with the stomata on the upper surface. In what are usually termed the foliose Hepaticæ, such as Jungermanniæ, a distinct stem is visible bearing leaves. All are cellular, no differentiation occurring beyond a compacting of the peripheral layers of cells. The mode of branching is usually dichotomous.

In Fungi the vegetative organs consist of a mass of cellular filaments, anastomosing and branching in various ways, constituting the *mycelium* or *spawn* (fig. 95, *m*), from which diversely-shaped portions of cellular tissue are developed, forming *receptacles* for the support of the reproductive organs. The mycelium creeps along in or upon the stratum whence it is nourished, sending up here and there a receptacle. The structural elements which form these are colourless cellular filaments, or *hyphæ*, divided usually by many transverse septa. These sometimes combine to form a dense mass of parenchyma. In some cases the hyphæ of the mycelium are densely interwoven, and form masses of definite shape, the outer layer of which (pseudo-parenchymatous) forms a hard shell or skin; such a mass is termed a *sclerotium*. The reproductive receptacle formed from the mycelium is also composed of hyphæ. When there is only a single hypha the reproductive bodies are borne on the ends of its branches; but more usually the branches of the hyphæ bearing the reproductive bodies unite to form a flattened expansion, the *hymenium*. As they contain no chlorophyll, Fungi take up assimilated matter from other organisms, and therefore are frequently parasites. Fungi.

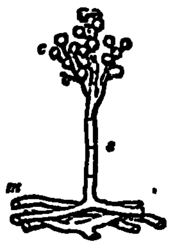


Fig. 95.

A species of Mould-fungus (*Botrytis*), consisting of a mycelium *m*, bearing a septate cellular stalk *s*, which branches at the apex, each division bearing a rounded spore *c*.

In Algæ the simplest forms present nothing but a cell-wall, containing a coloured protoplasmic substance, as in some Nostocaceæ. In some cases firmness is attained by deposition of silica as in Diatoms, or by lime carbonate as in Acetabularia. Lignification never occurs. More usually, however, the cells are combined into a tissue, but the forms which this may assume and the modes of combination are more various than in any other class of plants,—linear masses, strings, globes, laminæ, &c., being formed. There may be in some cases a slight differentiation into distinct organs. Thus, in some of the higher forms, as Fucaceæ, a distinct stem is formed, from which flattened thalli resembling leaf structures arise, and at the base root-like structures (*rhizoids*) are formed. These parts, however, have none of the internal structures which characterize higher plants, but consist entirely of cellular tissue. At most there is a condensation of cellular tissue at the periphery, forming an epidermis, and a similar condensation in the axis. The mode of branching amongst Algæ is either monopodial or dichotomous. Algæ.

In Lichens the thallus (fig. 96) consists of a *hyphal* element of anastomosing and interlacing filaments, amongst which are distributed rounded unicellular coloured bodies, the *gonidia* (fig. 97, *g*). These gonidia are either arranged Lichens.

in one layer in the thallus, which is then said to be *heteromerous* (the hypha layer being divided into a cortical and deeper part), or they are scattered equally throughout its substance and are *homœomerous*. The gonidia are separable, and may form independent plants. When they are being detached, the separation begins at the centre of the thallus, so that the middle of the Lichen becomes pulverulent, while its circumference may remain foliaceous or crustaceous. By the continuation of this process it sometimes happens that the whole Lichen becomes a mass of greenish or yellowish powder. The thallus may be crustaceous, in the form of an incrustation upon rocks, trees, &c., with which it becomes closely connected, as in Graphis; or it may be foliaceous, forming a flattened expansion easily detachable from the substratum to which it is connected by small root-like bodies or *rhizines*, as in Peltigera; or the lichen may be what is termed fruticose, *i.e.*, composed of a much-branched thallus rising from a single point of attachment, as in Usnea. Recent observations upon Lichens tend to show that they are in reality composed of two distinct organisms,—one, a Fungus, being the hyphal part, and the other, an Alga, the gonidial portion, and that the Fungus is parasitic upon the gonidia.

Fig. 96.

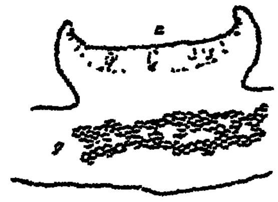


Fig. 97.

Fig. 96.—A Lichen (*Parmelia*), with its cellular expansion (thallus), and its rounded apothecia or cups of fructification.
Fig. 97.—Vertical section of an apothecium and thallus of a Lichen. Rounded free cells *g*, of a green colour, and called gonidia, are seen in the centre of the thallus. The apothecium *a* consists of thecæ and paraphyses. Its upper surface is often coloured and covered by a perithecium.

3. *Leaves and their Modifications.*

Leaves. In popular language all the green expanded organs borne upon an axis are designated leaves. Investigation, however, has shown that many other parts of a plant which externally appear very different from ordinary leaves are, in their essential particulars, very similar to them, and are in fact their morphological equivalents. Thus the scales on the bulb of the Onion, the various parts of the flower, &c., are all leaves. Assuming, then, that the structure ordinarily termed a leaf is the typical form, these latter are designated changed or *metamorphosed* leaves; and all structures morphologically equivalent with the leaf are included under the general term *phyllome* (leaf-structure). Leaves are produced as lateral outgrowths of the stem. This character, common to all leaves, distinguishes them from other organs. In the higher plants we can easily recognize the distinction between stem and leaf. Amongst the lower plants, however, it is found that a demarcation into stem and leaf is impossible, but that there is a structure which partakes of the characters of both,—such is a *thallome*. The leaves always arise from the outer portion of the primary meristem of the plant, and the tissues of the leaf are continuous with those of the stem. Every leaf originates as a simple cellular papilla, which consists of a development from the cortical layers covered by epidermis; and as growth proceeds, the fibro-vascular bundles of the stem are continued outwards, and finally expand and terminate in the leaf. The increase in length of the leaf by growth at the apex is usually of a limited nature. In some Ferns, however, there seems to be a provision for indefinite terminal growth, while in others this growth is periodically interrupted. It not unfrequently happens, especially amongst Monocotyledons, that after growth at the apex has ceased, it is continued at the base of the leaf, and in this way the length may be much increased. Amongst Dicotyledons this is very rare. In all cases the dimensions of the leaf are enlarged by interstitial growth of its parts.

Structure of leaves. The simplest leaf is found in some Mosses, where it consists of a single layer of cells. Usually it consists of several layers, and amongst vascular plants is distinguishable into an epidermis and a central parenchyma with fibro-vascular bundles distributed through it.

The *epidermis* (fig. 98, *es*, *ei*), composed of cells more or less compressed, has usually a different structure and aspect on the two surfaces of the leaf. It is chiefly on the epidermis of the lower surface (fig. 98, *ei*) that stomata, *st*, are produced, occupying spaces between the veins, and it is there also that hairs, *p*, usually occur. The lower epidermis is often of a dull or pale-green colour, soft, and easily detached. The upper epidermis is frequently smooth and shining, and sometimes becomes very hard and dense. Many tropical plants present on the upper surface of their leaves several layers of compressed epidermal cells. These appear to be essential for the preservation of moisture in the leaf. In leaves which float upon the surface of water, as those of the Water-lily, the upper epidermis alone possesses stomata.

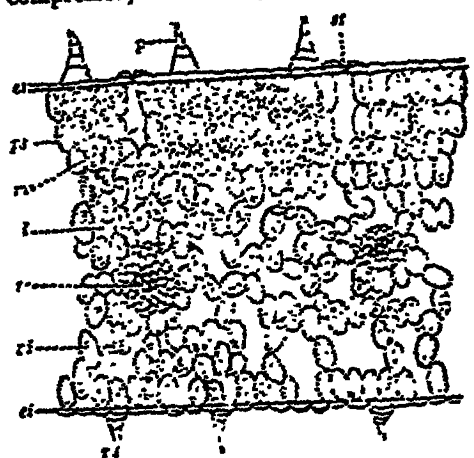


Fig. 98.

Section of a Melon-leaf, perpendicular to the surface. *es*, upper epidermis; *ei*, lower epidermis; *p*, hairs; *st*, stomata; *ps*, upper layers of parenchymatous cells; *pi*, lower layers of parenchymatous cells; *m*, meatus, or canals connected with stomata; they are sometimes called hypostomatic spaces; *l*, lacunæ, or cavities between the loose cells in the cavernous lower parenchyma; *fv*, bundles of fibro-vascular tissue, consisting of woody, dotted, spiral, and other vessels.

The *parenchyma* of the leaf is the cellular tissue surrounding the vessels, and enclosed within the epidermis (fig. 98, *ps*, *pi*). It has sometimes received the names of *diachyma*, *mesophyllum*, and *diploë*. It is formed of two distinct series of cells, each containing chlorophyll or green-coloured granules, but differing in form and arrangement. Below the epidermis of the upper side of the leaf there are one or two layers of oblong blunt cells, placed perpendicularly to the surface (fig. 98, *ps*), and applied so closely to each other as to leave only small intercellular spaces (fig. 98, *m*), except where stomata happen to be present. On the under side of the leaf the cells are irregular, often branched, and are arranged more or less horizontally (fig. 98, *pi*), leaving cavities between them, *l*, which often communicate with stomata. On this account the tissue has received the name of *cavernous*. In leaves having a very firm texture, as those of Coniferæ and Cycadaceæ, the cells of the parenchyma immediately beneath the epidermis are very much thickened and

elongated in a direction parallel to the surface of the leaf, so as to be fibre-like. These constitute a hypodermal layer, beneath which the chlorophyll cells of the parenchyma are densely packed together, and are elongated in a direction vertical to the surface of the leaf; this has been termed *palisade* tissue. The form and arrangement of the cells, however, depend much on the nature of the plant, and its exposure to light and air. Sometimes the arrangement of the cells on both sides of the leaf is similar, as occurs in leaves which have their edges presented to the sky. In very succulent plants the cells form a compact mass, and those in the centre are often colourless. In some cases the cellular tissue is deficient at certain points, giving rise to distinct holes in the leaf, as in Monstera Adansonii; such a leaf has been called *pertuse*. In Victoria regia perforations in the leaf seem to be subservient to the purposes of nutrition, by permitting the gases collected beneath the large expanded leaf to escape, and thus allowing its under surface to be brought into immediate contact with the water. The fibro-vascular system in the leaf constitutes the *venation*. The fibro-vascular bundles from the stem bend out into the leaf, and are there arranged in a definite manner. They usually form two layers, which may be separated by maceration. In *skeleton leaves*, or leaves in which the parenchyma is removed, these layers are well seen. In some leaves, as in the Barberry, the vessels forming the veins are hardened, producing spines without any parenchyma. The hardening of the extremities of the vascular tissue is the cause of the spiny margin of many leaves, such as the Holly, of the sharp-pointed leaves of Madder, and of mucronate leaves, or those having a blunt end with a hard projection in the centre.

Submerged leaves, or leaves which are developed under water, differ in structure from aerial leaves. They have usually no fibro-vascular system, but consist of a congeries of cells, which sometimes become elongated and compressed so as to resemble veins. They have a layer of compact cells on their surface, but no true epidermis, and no stomata. Their internal structure consists of cells, disposed irregularly, and sometimes leaving spaces which are filled with air for the purpose of floating the leaf. When exposed to the air these leaves easily part with their moisture, and become shrivelled and dry. In some instances there is only a network of filamentous-like cells formed, the spaces between which are not filled with parenchyma, giving a peculiar skeleton appearance to the leaf, as in Ouvirandra fenestralis (Lattice plant). Such a leaf has been called *fenestrate*. A leaf, whether aerial or submerged, generally consists of a flat expanded portion (fig. 99, *l*), called the *blade*, *limb*, or *lamina*, of a narrower portion called the *petiole* or *stalk* (fig. 99, *p*), and sometimes of a portion at the base of the petiole, which forms a *sheath* or *vagina* (fig. 99, *g*), or is developed in the form of leaflets, called *stipules* (fig. 123, *s*). The sheathing portion is sometimes incorporated with the stem, and is then called *tigellary*. These portions are not always present. The sheathing or stipulary portion is frequently wanting, and occasionally only one of the other two is developed. When a leaf has a distinct stalk it is called *petiolate*; when it has none, it is *sessile*, and if in this case it embraces the stem it is said to be *amplexicaul*. The part of the leaf next the petiole or the axis is the *base*, while the opposite extremity is the *apex*. The surfaces of the leaf are called the *paginæ*,

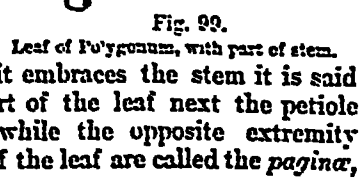


Fig. 99.
Leaf of Polygonum, with part of stem.

and its edges or margins form the *circumscription* of the leaf. The leaf is usually flattened and expanded horizontally, *i.e.*, at right angles to the longitudinal axis of the shoot, so that the upper pagina is directed towards the heavens, and the lower pagina towards the earth. In some cases leaves, as in Iris, or leaf-like petioles, as in Australian Acacias and Eucalypti, have their plane of expansion parallel to the axis of the shoot; or the leaf may have a cylindrical or polyhedral form, as in Mesembryanthemum. In other instances, as in Alströmeria, the leaf becomes twisted in its course, so that what is superior at one part becomes inferior at another. The upper angle formed between the leaf and the stem is called its *axil*, and everything arising at that point is called *axillary*. It is there that leaf-buds are usually developed. The leaf is sometimes articulated with the stem, and, when it falls off, a *scar* or *cicatricula* remains; at other times it is continuous with it, and then decays, while still attached to the axis. In their early state all leaves are continuous with the stem, and it is only in their after growth that articulations are formed. When leaves fall off annually they are called *deciduous*; when they remain for two or more years they are *persistent*, and the plant is called *evergreen*. The laminar portion of a leaf is occasionally articulated with the petiole, as in the Orange, and a joint at times exists between the vaginal or stipulary portion and the petiole.

Venation

The arrangement of the fibro-vascular system in the lamina constitutes the *venation* or *nervation*. In an ordinary leaf, as that of the Elm, there is observed a large central vein running from the base to the apex of the leaf, this is the *midrib* (fig. 100); it gives off veins laterally (*primary veins*), which either end in a curvature within the margin (*curve-veined*), as in Lilac and Belladonna, or go directly to the edge of the leaf (*feather-veined*), as in Elm (fig. 100) and Chestnut. If they are curved, then external veins and marginal veinlets are interspersed through the parenchyma external to the curvature. There are also other veins of less extent (*costal veins*) given off by the midrib, and these give origin to small *veinlets*. A leaf with only a single midrib is said to be *unicostate* (fig. 100). In some cases, as Sycamore and Cinnamon, in place of there being only a single midrib there are several large veins (ribs) of nearly equal size, which diverge from the point where the blade joins the petiole or stem, giving off lateral veins. The leaf in this case is *multicostate* (fig. 101). When there are three prominent ribs, as in Cinnamon and Cassia, the leaf is *tricostate*; when five, *quinquecostate*. When the midrib gives off two ribs a little above the base, the leaf becomes *triplicostate*; when it gives off five, *quintuplicostate*.

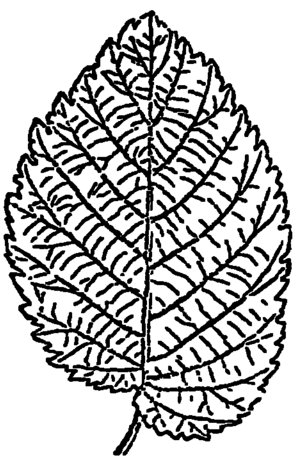


Fig. 100

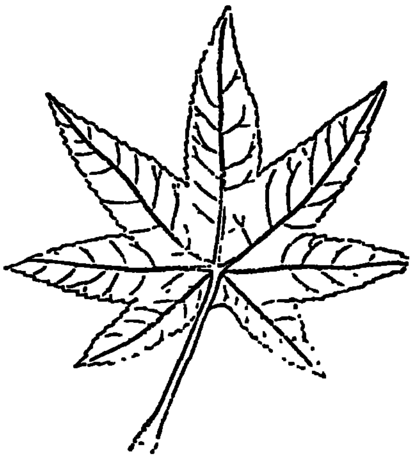


Fig. 101.

FIG. 100.—Leaf of *Ulmus effusa*. Reticulated venation; primary veins going to the margin, which is serrated. Leaf unequal at the base.

FIG. 101.—Multicostate divergent leaf of Castor-oil plant (*Ricinus communis*). It is palmately-cleft, and exhibits seven lobes at the margin. The petiole is inserted a little above the base, and hence the leaf is called peltate or shield-like.

In a leaf having many ribs they may converge towards the apex, as in Cinnamon, or they may diverge, as in Sycamore and the Castor-oil plant (fig. 101). Thus the primary veins give off secondary veins, and these in their turn give off tertiary veins, and so on until a complete network of vessels is produced, and those veins usually project on the under surface of the leaf. To a distribution of veins such as this the name of *reticulated* or *netted* venation has been applied. In the leaves of some plants there exists a midrib with large veins running nearly parallel to it from the base to the apex of the lamina, as in Grasses (fig. 102); or with veins diverging from the base of the lamina in more or less

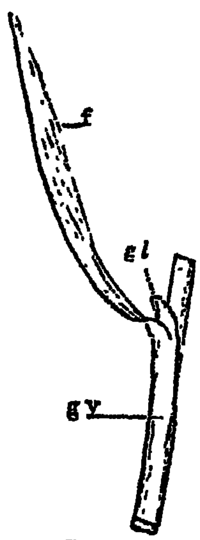


Fig. 102.

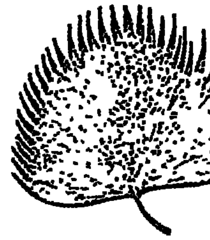


Fig. 103.

FIG. 102.—Stem of a Grass (*Poa*) with leaf. The sheathing petiole *gv* ending in a process *gl*, called a ligule; the blade of the leaf, *f*.
FIG. 103.—Leaf of Fan Palm (*Chamærops*), showing the veins running from the base to the margin, and not forming an angular net-work.

parallel lines, as in Fan Palms (fig. 103), or with veins coming off from it throughout its whole course, and running parallel to each other in a straight or curved direction towards the margin of the leaf, as in Plantain and Banana. In these cases the veins are often united by cross veinlets, which do not, however, form an angular network. Such leaves are said to be *parallel-veined*. The leaves of Monocotyledons have generally this kind of venation, while reticulated venation most usually occurs amongst Dicotyledons. Some plants, which in most points of their structure are Monocotyledonous, yet have reticulated venation. Such have been called Dictyogens. In vascular Acotyledonous plants there is frequently a tendency to fork exhibited by the fibro-vascular bundles in the leaf; and when this is the case we have *fork-veined* leaves. This is well seen in many Ferns. The distribution of the system of vessels in the leaf is usually easily traced, but in the case of succulent plants, as Hoya, Agave, Stonecrop, and Mesembryanthemum, the veins are obscure, and the leaves are said to be *hidden-veined*. In the cellular leaves of Mosses a median vein of several layers of cells is often visible, but as there are no fibro-vascular bundles present this is considered a false venation, and they are styled *veinless* (*Avenia*).

TABULAR ARRANGEMENT OF VENATION.

A.—Reticulated Venation.
- I. *Unicostate*. A single rib or costa in the middle (midrib).
  - 1. Primary veins coming off at different points of the midrib.
    - *a*. Veins ending in curvatures within the margin, and forming what have been called *true netted* leaves (Lilac).
    - *b*. Veins going directly to the margin and forming *feather-veined* leaves (Oak and Chestnut).
  - 2. Primary veins coming off along with the midrib from the base of the leaf.
- II. *Multicostate*. More than one rib. Authors usually give to these leaves the general name of *costate* or *ribbed*.
  - 1. *Convergent*. Ribs converging, running from base to apex in a curved manner, as in Cinnamon and Melastoma. There is occasionally an obscure rib running close to the edge of the leaf, and called intra-marginal, as in the Myrtle.
  - 2. *Divergent*. Ribs diverging or proceeding in a radiating manner, as in Sycamore, Vine, Geranium, Castor-oil plant.

B.—Parallel Venation.—The term parallel is not strictly applicable, for the veins often proceed in a radiating manner, but it is difficult to find a comprehensive term. This venation may be characterised as *not reticulated*.
- I. Veins proceeding transversely from midrib to margin, usually with convexity towards the midrib, as in Musa and Canna.
- II. Veins proceeding longitudinally from base to apex.
  - 1. Veins more or less convergent, as in Iris, Lilies, Grasses.
  - 2. Veins more or less divergent, as in Fan Palms.

C.—Furcate Venation. Veins dividing in a forked manner, as in the case of many Ferns.

In all plants, except Thallophytes, leaves are present at some period of their existence. In Cuscuta (Dodder), however, we have an exception. The forms assumed by leaves vary much, not only in different plants but in the same plant. It is only amongst the lower classes of plants,—Mosses, Characeæ, &c.,—that all the leaves on a plant are similar. As we pass up the scale of vegetable life we find them becoming more and more variable. The structures in ordinary language designated as leaves are considered so *par excellence*, and they are frequently spoken of as *foliage leaves*. In relation to their production on the stem we may observe that when they are small they are always produced in great number, and as they increase in size their number and rapidity of growth diminish correspondingly. The cellular process from the axis which develops into a leaf is simple and undivided; it rarely remains so, but in progress of growth becomes segmented in various ways, either longitudinally or laterally, or in both ways. By longitudinal segmentation we have a leaf formed consisting of vagina, petiole, and lamina; or one or other of these may be absent, and thus stalked, sessile, sheathing, &c., leaves are produced. Lateral segmentation affects the lamina, producing indentations, lobings, or fissuring of its margins. In this way two marked forms of leaf are produced—(1.) *Simple* form, in which the segmentation, however deeply it extends into the lamina, does not separate portions of the lamina which become articulated with the midrib or petiole; and (2.) *Compound* form, where portions of the lamina are separated as detached *leaflets* (*foliola*), which become articulated with the midrib or petiole. In simple leaves, then, there is never more than one articulation, which is at the point of their insertion on the stem. In compound leaves there are one or more articulations beyond the point of insertion on the stem. In both simple and compound leaves, according to the amount of segmentation and the mode of development of the parenchyma and direction of the fibro-vascular bundles, many forms are produced. Forms of leaves. Plate X.

Simple Leaves.—When the parenchyma is developed symmetrically on each side of the midrib or stalk, the leaf is *equal*; if otherwise, the leaf is *unequal* or *oblique* (fig. 100). If the margins are even and present no divisions, the leaf is *entire* (fig. 104); if there are slight projections of cellular or vascular tissue beyond the margin the leaf is not entire; when the projections are irregular and more or less pointed, the leaf is *dentate* or toothed; when they lie regularly over each other, like the teeth of a saw, the leaf is *serrate* (fig. 100); when they are rounded the leaf is *crenate*. If the divisions extend more deeply into the lamina than the margin, the leaf receives different names according to the nature of the segments; thus, when the divisions extend about half-way down (fig. 105), it is *cleft* (*fissus*), and its lines of separation are called *fissures*; when Simple leaves.

the divisions extend nearly to the base or to the midrib the leaf is *partite*, and its lines of separation are called *partitions.*

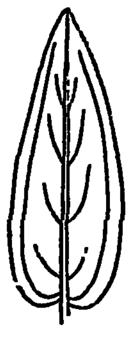


Fig. 104.

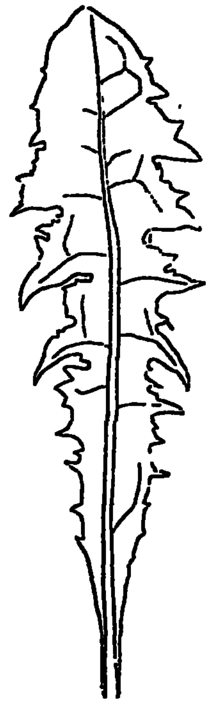


Fig. 105.

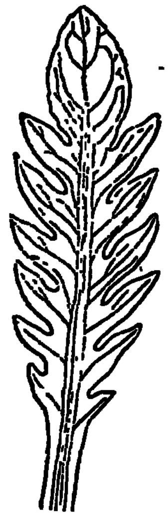


Fig. 106.

Fig. 104.—Ovate acute leaf of *Coriara myrtifolia*, one of the adulterations of senna. Besides the midrib there are two intra-marginal ribs which converge to the apex. The leaf is therefore tricostate.
Fig. 105.—Runcinate leaf of Dandelion (*Leontodon Taraxacum*). It is a pinnatifid leaf, with the divisions pointing towards the petiole.
Fig. 106.—Pinnatifid leaf of *Valeriana dioica*.

If these divisions take place in a simple *feather-veined* leaf it becomes either *pinnatifid* (fig. 106), when the segments extend to about the middle and are broad; or
ates I. *pectinate*, when they are narrow; or *pinnatipartite*, when
d VIII. the divisions extend nearly to the midrib. These primary divisions may be again subdivided in a similar manner, and thus a *feather-veined* leaf will become *bipinnatifid* or *bipinnatipartite;* and still further subdivisions give origin to *tripinnatifid* and *laciniated* leaves. If the divisions of a pinnatifid leaf are more or less triangular, and point downwards towards the base, the extremity of the leaf being undivided and triangular, the leaf is *runcinate* (fig.
ate IX. 105), as in the Dandelion. When the apex consists of a large rounded lobe, and the divisions, which are also more or less rounded, become gradually smaller towards the base, as in Barbarea, the leaf is called *lyrate*, from its resemblance to an ancient lyre. When there is a concavity on each side of a leaf, so as to make it resemble a violin, as in Rumex pulcher, it is called *panduriform*. The same kinds of divisions taking place in a simple leaf with *radiating* venation, give origin to *lobed*, *cleft*, and *partite* forms. When the divisions extend about half-way through the leaves, they may be *three-lobed*, *five-lobed*, *seven-lobed*, *many-lobed*, or *trifid*, *quinquefid*, *septemfid*, *multifid*, according to the number of the divisions. The name *palmate*, or *palmatifid* (fig. 101), is the general term applied to leaves with radiating venation, in which there are several lobes united by a broad expansion of parenchyma, like the
'late VI. palm of the hand, as in the Castor oil plant, Rheum palma-
g. 1. tum, and Papaw. The divisions of leaves with radiating venation may extend to near the base of the leaf, and the names *bipartite*, *tripartite*, *quinquepartite* (fig. 107), *septempartite*, *digitipartite* (Plate II. fig. 1), are given according as the partitions are two, three, five, seven, or more. In Drosera dichotoma bipartite and tripartite leaves are seen. The term *dissected* is applied to leaves with radiating venation, having numerous narrow divisions, as in Geranium dissectum.

When in a radiating leaf there are three primary partitions, and the two lateral lobes are again cleft, as in Helleborus

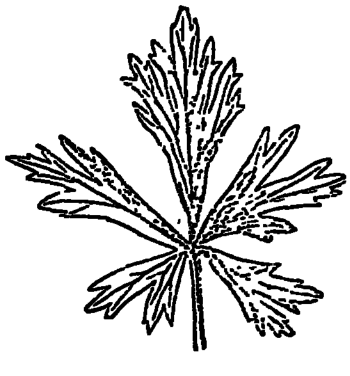


Fig. 107.

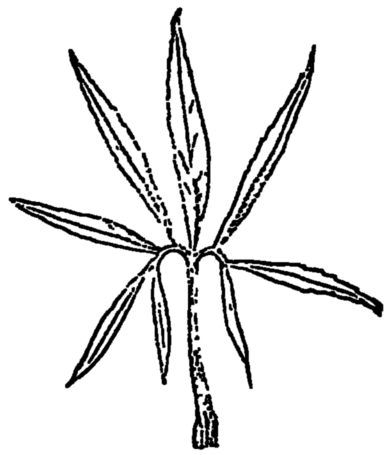


Fig. 108.

Fig. 107.—Five-partite leaf of Aconite. Such a leaf is sometimes called palmipartite, palmately-partite, or dissected. The venation is radiating, and the segments of the leaf are cuneate, and each of them is cleft and toothed at the apex
Fig. 108.—Pedate leaf of Stinking Hellebore (*Helleborus fœtidus*). The venation is radiating. It is a palmately-partite leaf, in which the lateral lobes are deeply divided. When the leaf hangs down it resembles the foot of a bird, and hence the name.

(fig. 108), the leaf is called *pedate* or *pedatifid*, from a fancied resemblance to the claw of a bird. In all the instances already alluded to the leaves have been considered as flat expansions, in which the ribs or veins spread out on the same plane with the stalk. In some cases, however, the veins spread at right angles to the stalk. If they do so equally on all sides, and are united by parenchyma, so that the stalk occupies the centre, the leaf becomes *orbicular*, as in Hydrocotyle; if unequally, so that the stalk is not in the centre, the leaf is *peltate*, as in Indian Cress (fig. 109). The edges or margins of orbicular and peltate leaves are often variously divided.

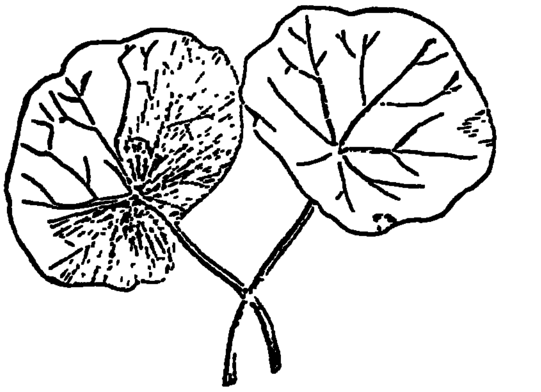


Fig. 109.

Fig. 110.

Fig. 109.—Peltate leaves of Indian Cress (*Tropæolum majus*).
Fig. 110.—Lanceolate leaf of a species of Senna.

Without attempting to notice all the forms of leaves, the following are enumerated as the most important. When the veins do not spread out, but run fron the apex with a narrow strip of parenchyma, *linear* or *acicular*, as in Pines and Firs. The hence called in Germany *Nadel-hölzer*, or When the veins diverge, those in the middle be and *the leaf tapering at each end* (fig. 110), *lanceolate*. If the middle veins exceed the otl and the ends are convex, the leaf is either *round*, *oval*, or *oblong* (fig. 111). If the veins at the base and the leaf narrows to the top, it is *ovate* or (fig. 104), as in Chickweed; if the apex is broa is *obovate*, or inversely egg-shaped (fig. 112). *cuneate* or wedge-shaped, in Saxifraga; *sp* spatula-like, having a broad rounded apex, a

down to the stalk, as in the Daisy; *subulate*, narrow and tapering like an awl; *acuminate*, or drawn out into a long point, as in Ficus religiosa; *mucronate*, with a hard stiff point or mucro at the apex. When the parenchyma is deficient at the *apex* so as to form two rounded lobes, the leaf is *obcordate* or inversely heart-shaped; when the deficiency is
Plate IV. very slight the leaf is called *emarginate* (fig. 112), as having a portion taken out of the margin; when the apex is merely flattened or slightly depressed the leaf is *retuse;* and when the apex ends abruptly in a straight margin, as in the Tulip-tree, the leaf is *truncate*. When the veins at the base of the lamina are prolonged downwards at an obtuse angle with the midrib, and rounded lobes are formed, as in

Fig. 111.

Fig. 112.

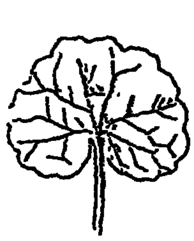


Fig. 113.

Fig. 114.

Fig. 111.—Oblong leaf of a species of Senna.
Fig. 112.—Emarginate leaf of a species of Senna. The leaf in its contour is somewhat obovate, or inversely egg-shaped, and its base is oblique.
Fig. 113.—Reniform leaf of *Nepeta Glechoma*, margin crenate.
Fig. 114.—Sagittate leaf of Convolvulus.

Dog-violet, the leaf is *cordate* or heart-shaped; it is kidney-shaped or *reniform* (fig. 113), when the apex is rounded as in Asarum. When the lobes are prolonged downwards and are acute, the leaf is *sagittate* (fig. 114); when they proceed at right angles, as in Rumex Acetosella, the leaf is *hastate* or halbert-shaped. When a simple leaf is divided at the base into two leaf-like appendages, it is called *auriculate*. When the veins spread out in various planes, and there is a large development of cellular tissue, so as to produce a succulent leaf, such forms occur as *conical, prismatical, ensiform* or sword-like, *acinaciform* or scimitar-shaped, and *dolabriform* or axe-shaped. When the development of parenchyma is such that it more than fills up the spaces between the veins, the margins become *wavy, crisp,* or *undulated*, as in Rumex crispus and Rheum undulatum. By cultivation the cellular tissue is often much increased, giving rise to the *curled* leaves of Greens, Savoys, Cresses, Lettuce, &c. In Rushes the shoots which act as leaves are often *terete*. They are either barren or bear flowers. Their cellular tissue is often stellate, and the shoots sometimes exhibit a peculiar spiral twisting. Amongst parallel veined leaves the margins are usually entire, especially when the veins converge.

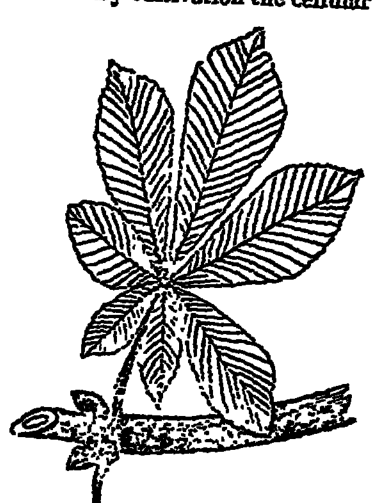


Fig. 115.

Septenate leaf of the Horse-chestnut (*Æsculus Hippocastanum*). Such leaves, especially when there are five leaflets, are called digitate.

Compound leaves. Compound leaves are those in which the divisions extend to the midrib or petiole, and the separated portions become each articulated with it, and receive the name of *foliola* or *leaflets*. The midrib, or petiole, has thus the appearance of a branch with separate leaves attached to it, but it is considered properly as one leaf, because in its earliest state it arises from the axis as a single piece, and its subsequent divisions in the form of leaflets are all in one plane. The leaflets are either sessile (fig. 115), or have stalks, called *petiolules* (fig. 116), according as the vascular bundles of the veins spread out or divaricate at once, or remain united for a certain length. Compound leaves have been classified according to the nature of the venation and the development of parenchyma. If we suppose that in a simple feather-veined unicostate leaf the divisions extend to the midrib, and each of the primary veins spreads out or branches, and becomes surrounded with parenchyma, and the leaflets thus formed become articulated to the petiole or midrib (fig. 116), the leaf becomes compound and

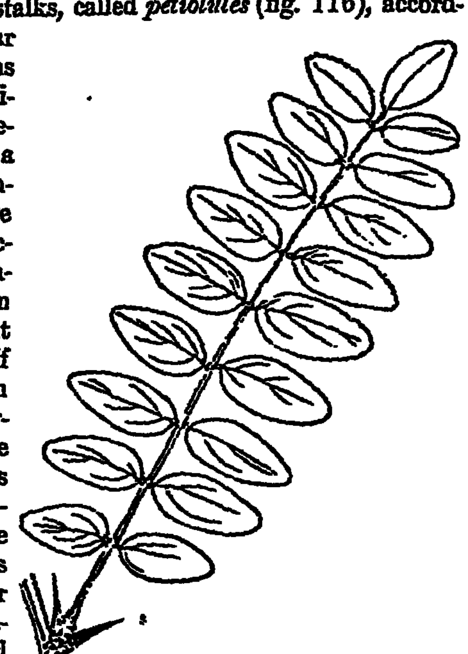


Fig. 116.

Impari-pinnate (unequally pinnate) leaf of Robinia. There are nine pairs of shortly-stalked leaflets (foliola, pinnæ), and an odd one at the extremity. At the base of the leaf stipules *s* are seen.

pinnate. If the midrib and primary veins are not covered Plate XV.
with parenchyma, while the *secondary* (or those coming off in a feather-like manner from the primary veins) are, and separate leaflets are thus formed which are articulated with the veins, the leaf is *bipinnate*. In this case the secondary veins form as it were partial petioles. A farther subdivision, in which the *tertiary* veins only are covered with parenchyma and have separate leaflets, gives *tripinnate* or *decompound* forms, in which case the tertiary veins form the partial petioles. A leaf divided still more is called *supradecompound*. When a pinnate leaf has one pair of leaflets it is *unijugate;* with two pairs, it is *bijugate;* with many pairs, *multijugate* (fig. 116). When a pinnate leaf ends in a pair of pinnæ it is *equally* or *abruptly pinnate* (pari-pinnate); when there is a single terminal leaflet (fig. 116), the leaf is *unequally pinnate* (impari-pinnate); when the leaflets or pinnæ are placed alternately on either side of the midrib, and not directly opposite to each other, the leaf is *alternately pinnate;* and when the pinnæ are of different sizes, the leaf is *interruptedly pinnate*. In the case of a simple multicostate leaf with radiating venation, if we suppose the ribs to be covered with parenchyma, so as to form separate leaflets, each of which is articulated to the petiole, the *digitate* form of compound leaf is produced; if there are three leaflets the form is *ternate* or *trifoliate;* Plate V
if four, *quaternate;* if five, *quinate;* if seven, *septenate;* and so on. If the three ribs of a ternate leaf subdivide each into three primary veins, which become covered with parenchyma so as to be separate articulated leaflets, the leaf is *biternate;* and if another threefold division takes place, it is *triternate*.

The *petiole* or leaf-stalk is the part which unites the limb Petiole.
or blade of the leaf to the stem (fig. 99, *p*). It is absent in *sessile* leaves, and this is also frequently the case when the vagina is present, as in Grasses. It consists of a mass of fibro-vascular bundles with a varying amount of cellular

tissue. The vessels are enclosed in an epidermal covering, with few stomata, and are more or less compressed. When the vascular bundles reach the base of the lamina they separate and spread out in various ways, as already described under venation. At the place where the petiole joins the stem there is frequently an articulation, or a constriction with a tendency to disunion, and at the same time there exists a swelling (fig. 117, *p*), called *pulvinus*, formed of cellular tissue, the cells of which exhibit the phenomenon

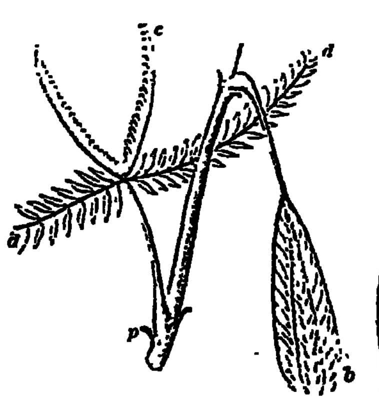


Fig. 117.

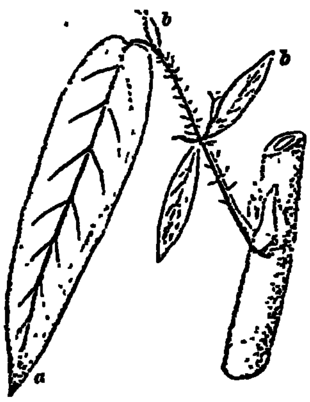


Fig. 118.

FIG. 117.—Branch and leaves of the Sensitive plant (*Mimosa pudica*), showing the petiole in its erect state, *a*, and in its depressed state, *b*; also the leaflets closed, *c*, and the leaflets expanded, *d*. Irritability resides in the pulvinus *p*, and in the struma.

FIG. 118.—A portion of the branch and leaf of the Moving plant of India (*Hedysarum* or *Desmodium gyrans*). The leaf is impari-pinnate, and often pinnately-trifoliate. The large leaflet or pinna, *a*; the smaller leaflets, *b*, of which there are either one or two pairs. The leaflets are in constant motion.

of irritability (figs. 117, 118). At the point where the petiole passes into the lamina, or where the midrib joins the leaflets of a compound leaf, there is occasionally a cellular dilatation called *struma*, and an articulation. In Mimosa pudica a sensitiveness is located in the pulvinus (fig. 117, *p*), which upon irritation induces a depression of the whole bipinnate leaf; a similar property exists in the struma at the base of the leaflets which fold upwards. In Desmodium gyrans (fig. 118) the pulvinus and struma have a similar power of causing movements of the large terminal leaflet and the two smaller lateral ones. In other cases the petiole is not articulated, but is continuous either with the stem, or with the sheath (vagina). The articulation or joint is by many considered as indicating a compound leaf, and hence the leaf of the Orange is considered as such, although it has an undivided lamina (fig. 119, *l*). In articulated leaves, the pulvinus may be attached either to the petiole or to the axis, and may fall with the leaf, or remain attached to the stem. When articulated leaves drop, their place is marked by a cicatrix or scar, seen below the bud in fig. 63. In this scar the remains of the vascular bundles *c* are seen; and its form furnishes characters by which particular kinds of trees may be known when not in leaf. In the case of many Palms and Tree-ferns the scars or cicatrices of the leaves are very conspicuous. In fossil plants important characters are founded on them.

When there is no articulation between the petiole and the stem, as is the case with many Monocotyledons, the leaf is continuous with the axis, and is not deciduous, but withers on the stalk. In many Liliaceous plants the leaves during their decay continue attached to the plants. The petiole varies in length, being usually shorter than the lamina, but sometimes much longer. In some Palms it is 15 or 20 feet long, and is so firm as to be used for poles or walking-sticks. In general, the petiole is more or less rounded in its form, the upper surface being flattened or grooved. Sometimes it is compressed laterally, as in the Aspen, and to this peculiarity the trembling of the leaves of this tree is attributed. In aquatic plants the leaf-stalk is sometimes distended with air, as in Pontederia and Trapa, so as to float the leaf. At other times it is *winged*, and is either leafy, as in the Orange (fig. 119, *p*), Lemon, and Dionæa (fig. 46, *p*), or pitcher-like, as in the Pitcher-plant

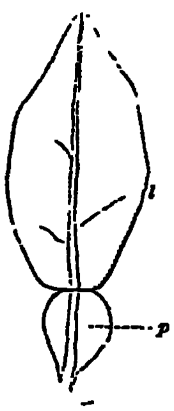


Fig. 119.

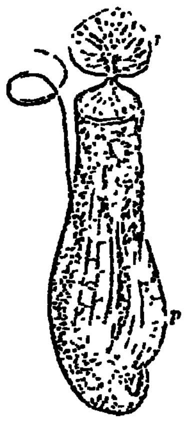


Fig. 120.

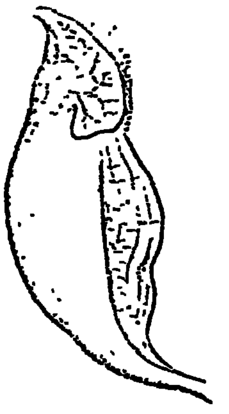


Fig. 121.

FIG. 119.—Leaf of Orange (*Citrus Aurantium*), showing a winged leafy petiole *p*, which is articulated to the lamina *l*. It is considered a compound leaf, having only one leaflet.

FIG. 120.—Pitcher of a species of Pitcher-plant (*Nepenthes distillatoria*). It is supposed to be formed by a folded petiole *p*, the edges of which are united. The lid *l* at the top is supposed to represent the lamina, united by articulation to the pitcher.

FIG. 121.—Pitcher (*ascidium*) of a species of Side-saddle plant (*Sarracenia purpurea*). The pitcher is supposed to be formed by the folded petiole, which is prolonged.

(fig. 120, *p*) and Sarracenia (fig. 121). Leafy petioles are occasionally united to the axis for some extent, and thus become *decurrent*. In some Australian Acacias, and in some species of Oxalis and Bupleurum, the petiole is flattened in a vertical direction, the vascular bundles separating immediately after quitting the stem, and running nearly parallel from base to apex. This kind of petiole (fig. 122, *p*) has been called *phyllodium*. In these plants the laminæ or blades of the leaves are pinnate, bipinnate, or ternate, and are produced at the extremities of the phyllodia in a horizontal direction; but in many instances they are not developed, and the phyllodium serves the purpose of a leaf. Hence some Acacias are called leafless. These phyllodia, by their vertical position and their peculiar

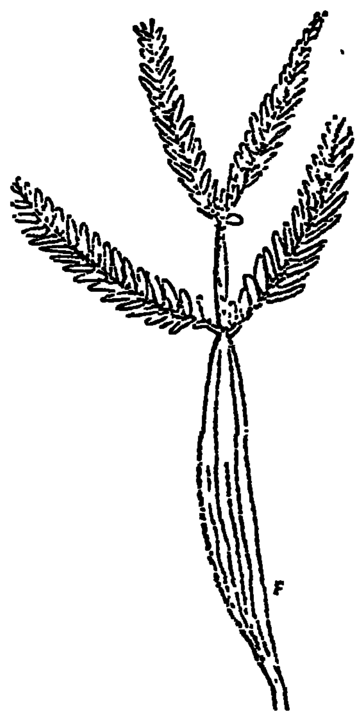


Fig. 122.

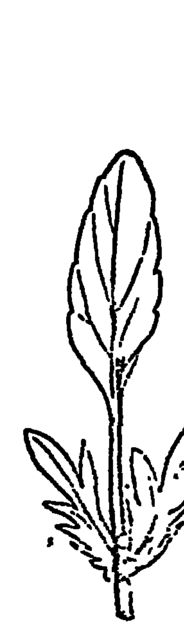


Fig. 123.

FIG. 122.—Leaf of an Acacia (*Acacia* [illegible]), showing a flattened leaf-like petiole *p*, called a phyllodium, with straight venation, and a bipinnate lamina *l*.

FIG. 123.—Leaf of Pansy, *l*, separated from the stem; the lyrato-pinnatifid stipules *s* are distinctly visible, and their lateral position is seen.

form, give a remarkable aspect to vegetation. On the same Acacia there occur leaves with the petiole and lamina

perfect; others having the petiole slightly expanded or winged, and the lamina imperfectly developed; and others in which there is no lamina, and the petiole becomes large and broad. Some petioles, in place of ending in a lamina become changed into a delicate filiform body, a *tendril* or *cirrus*, so as to enable the plant to climb. In many leaves interposed betwixt the petiole and the stem, or, in sessile leaves, betwixt the lamina and the stem, an expansion of the foliar tissue takes place, so that a *sheath* (*vagina*) is formed, which embraces the whole or part of the circumference of the stem (fig. 102, *gv*). This sheath is comparatively rare in Dicotyledons, but is seen in

Plate VII. Umbelliferous plants, where it constitutes the *pericladium*, and in the Rhubarb order, where it is large and membranous, and has received the name of *ochrea* or boot. It is much more common amongst Monocotyledons. In Palms it forms a kind of network, to which the name of *reticulum* has been given. In Sedges the sheath forms a complete investment of the stem, whilst in Grasses (fig. 102) it is split on one side. In the latter plants there is also a membranous outgrowth at right angles to the median plane of the leaf from the point where the sheath passes into the lamina (there being no petiole). To this structure the name of *ligule* (fig. 102, *gl*) has been given. It is of various dimensions, and thus gives a character to the plants.

Stipules. In leaves in which no sheath is produced we not unfrequently find small foliar organs at the base of the petiole. These have been denominated *stipules* (fig. 123, *s*). The stipules are often two in number, and they are important as supplying characters in certain natural orders. Thus they occur in the Pea and Bean family, in Rosaceous plants, and the Cinchona bark family. They are not common in Dicotyledons with opposite leaves. Plants having stipules are called *stipulate;* those having none are *exstipulate*. Stipules are formed by some of the vascular bundles diverging as they leave the stem, and becoming covered with parenchyma, so as to resemble true leaves. Like leaves they are large or small, entire or divided, deciduous or persistent, articulated or non-articulated. They are not usually of the same form as the ordinary foliage leaves of the plant, from which they are distinguished by their lateral position at the base of the petiole. In the Pansy (fig. 123) the true leaves *l* are stalked and crenate, while the stipules *s* are large, sessile, and pinnatifid. In Lathyrus Aphaca, and some other plants, the true pinnate leaves are abortive, the petiole forms a tendril, and the stipules alone are developed, performing the office of leaves. When stipules are attached separately to the stem at the base of the leaf, they are called *caulinary*, as in Salix aurita. When stipulate leaves are opposite to each other, at the same height on the stem, it occasionally happens that the stipules on the two sides unite wholly or partially, so as to form an *interpetiolary* or *interfoliar* stipule, as in Cinchona and in Ipecacuan. In the case of alternate leaves, the stipules at the base of each leaf are sometimes united to the petiole and to each other, so as to form an *adnate*, *adherent*, or *petiolary* stipule, as in the Rose, or an *axillary* stipule, as in Houttuynia cordata. In other instances the stipules unite together on the side of the stem opposite the leaf, and become *synochreate*, as in Astragalus. This so-called union or adhesion of stipules is not an accidental adhesion taking place after they have been developed. In these cases the parts never were separate; from the first they are developed as one portion. In the development of the leaf the stipules frequently play a most important part. They begin to be formed after the origin of the leaves, but grow much more rapidly than the leaves, and in this way they arch over the young leaves and form protective chambers wherein the parts of the leaf may develop. In Ficus, Magnolia, and Potamogeton they are very large and completely envelop the young leaf-bud. The stipules are sometimes so minute as to be scarcely distinguishable without the aid of a lens, and so fugacious as to be visible only in the very young state of the leaf. They may assume a hard and spiny character, as in Robinia Pseudacacia, or may be cirrose, as in Smilax, where each stipule is represented by a tendril; while in Cucurbitaceæ there is only one cirrose stipule. At the base of the leaflets or foliola of a compound leaf, small stipules are occasionally produced, to which some have given the name of *stipels*.

Variations in the structure and forms of leaves and leaf-stalks are produced by the increased development of cellular tissue, by the abortion or degeneration of parts, by the multiplication or repetition of parts, and by adhesion. Abnormalities. When cellular tissue is developed to a great extent, leaves become succulent and occasionally assume a crisp or curled appearance. Such changes take place naturally, but they are often increased by the art of the gardener, and the object of many horticultural operations is to increase the bulk and succulence of leaves. It is in this way that Cabbages and Savoys are rendered more delicate and nutritious. By a deficiency in development of parenchyma and an increase in the fibro-vascular tissue, leaves are liable to become hardened and spinescent. The leaves of Barberry and of some species of Astragalus, and the stipules of the False Acacia (Robinia) are spiny. To the same cause is attributed the spiny margin of the Holly-leaf. In the Gooseberry, the swelling (pulvinus) at the base of the petiole, and below the leaf, assumes a spinose character. Changes in the appearances of leaves are produced by adhesions and foldings of various kinds. When two lobes at the base of a leaf are prolonged beyond the stem and unite (fig. 124), the leaf is *perfoliate*, the stem appearing to pass through it, as in Bupleurum perfoliatum and Chlora perfoliata; when two leaves unite by their bases they become *connate* (fig. 125), as in Lonicera Caprifolium;

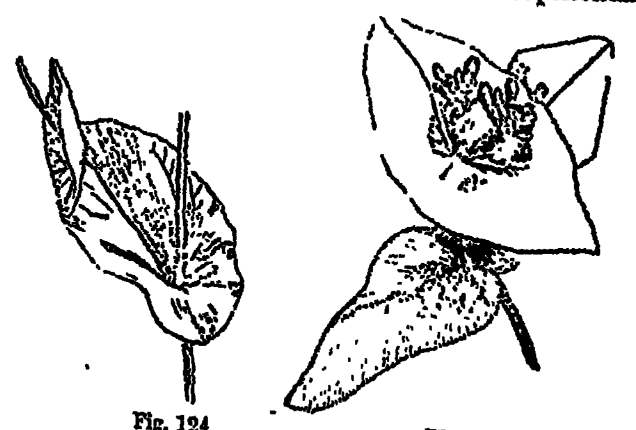


Fig. 124. Fig. 125.

FIG. 124.—Perfoliate leaf of a species of Hare's-ear (*Bupleurum rotundifolium*). The two lobes at the base of the leaf are united, so that the stalk appears to come through the leaf.
FIG. 125.—Connate leaves of a species of Honeysuckle (*Lonicera Caprifolium*). Two leaves are united by their bases.

and when leaves adhere to the stem, forming a sort of winged or leafy appendage, they are *decurrent*, as in Thistles. The formation of peltate and orbicular leaves has been traced to the union of the lobes of a cleft leaf. In the leaf of the Victoria regia the transformation may be traced during germination. The first leaves produced by the young plant are linear, the second are sagittate and hastate, the third are rounded-cordate, and the next are orbicular. The cleft indicating the union of the lobes remains in the large leaves. The parts of the leaf are frequently transformed into *tendrils* (*cirri*), with the view of enabling the plants to twine round others for support. In Leguminous plants (the Pea tribe) the pinnæ are frequently cirrose. When tendrils occupy the place of leaves, and Tendrils.

appear as a continuation of the leaf-stalk, they are called *petiolary*, as in Lathyrus Aphaca, in which the stipules perform the function of true leaves. In Flagellaria Indica, Gloriosa superba, Anthericum cirrhatum, and Albuca cirrhata, the midrib of the leaf ends in a tendril. In Smilax there are two stipulary tendrils, while in the Cucumber tribe there is a single one at the base of each leaf. In the Passion-flower the lateral leaf-buds, and in the Vine the terminal ones, become tendrils. In the Vanille plant (*Vanilla aromatica*) the tendrils are produced opposite the leaves, until the plant gains the top of the trees by which it is supported,—the upper tendrils being then developed as leaves. The midrib is sometimes prolonged in a cup-like or funnel-shaped form; this is occasionally seen in the common Cabbage, and seems to depend on the vascular bundles of the midrib spreading out at their extremity in a radiating manner, and becoming covered with parenchyma in such a way as to form a hollow cavity in the centre.

The vascular bundles and cellular tissue are sometimes developed in such a way as to form a circle, with a hollow in the centre, and thus give rise to what are called *fistular* or hollow leaves, as in the Onion, and to *ascidia* or *pitchers*.

em. Pitchers are formed either by petioles or by laminæ, and they are composed of one or more leaves. In Sarracenia (fig. 121) and Heliamphora, the pitcher is composed apparently of the petiole of the leaf. In Nepenthes (fig. 120) and perhaps in Cephalotus, while the folding of a winged petiole *p* forms the pitcher, the lid *l*, which is united by an articulation, corresponds to the lamina. This kind of ascidium is called *calyptrimorphous*, and may be considered as formed by a leaf, such as that of the Orange (fig. 119); the lamina *l* being articulated to the petiole *p*, which, when folded, forms the pitcher. In Dischidia Rafflesiana, a climbing plant of India, the pitchers are formed by the lamina of the leaf, and have an open orifice into which the rootlets at the upper part of the plant enter. These pitchers would seem, therefore, to contain a supply of fluid for the nourishment of the upper branches of the plant. In Utricularia the leaves form sacs called *ampullæ*. Some suppose that pitchers are not due to folding and adhesion, but that they are produced by a hollowing out of

s. the extremity of the stalk. In some cases the leaves are reduced to mere *scales*; they are then frequently called *cataphyllary* leaves. They are produced abundantly upon underground shoots. In parasites (Lathræa, Orobanche), and in plants growing on decaying vegetable matter (*Saprophytes*), in which no chlorophyll is formed, these scales are the only leaves produced. In Pinus the only leaves produced on the main stem and the lateral shoots are scales, the acicular leaves of the tree growing from axillary

e XV. shoots. In Cycas whorls of scales alternate with large pinnate leaves. In many plants, as already noticed, phyllodia or stipules perform the function of leaves. The production of leaf-buds from leaves has already been noticed. Such leaves are termed *proliferous*. In Bryophyllum (fig. 67) this is a common occurrence, and it is met with in many plants of the order Gesneraceæ. The leaf of Venus's Fly-trap (Dionæa muscipula, fig. 46), when cut off and placed in damp moss, with a pan of water underneath and a bell-glass for a cover, has produced buds from which young plants were obtained. Some species of Saxifrage and of Ferns also produce buds on their leaves and fronds. In Nymphæa micrantha buds appear at the upper part of the petiole.

ves in otyle- s. Amongst Dicotyledons we have leaves which present the greatest amount of variation in structure and form. The venation is reticulated. They are frequently articulated, exhibit divisions at their margin, and become truly compound. There are, no doubt, instances in which the veins proceed in a parallel manner, but this will be found to occur chiefly in cases where the petiole may be considered as occupying the place of the leaf. Examples of this kind are seen in Acacias (fig. 122). Dicotyledons rarely have a sheath developed, but stipules are very commonly present.

Leaves in Monocotyledons. In Monocotyledons the leaves do not present an angular network of vessels, nor do they, as a rule, exhibit divisions on their margin. Exceptions to this occur in some plants, as Tamus and Dioscorea, which have been called Dictyogens by Lindley, on account of their somewhat netted venation; and in Palms, in which, although the leaves are entire at first, they afterwards become split into various lobes. They are rarely stipulate, and very frequently have a sheath at their base. The petiole is often absent, and a sheathing ligule takes its place. The leaves are often continuous with the stem. In some aquatic Monocotyledons the submerged and floating leaves are narrow, like petioles, while those growing erect above the water expand. This is seen in Sagittaria sagittifolia, in which the erect leaves assume an arrow-like shape.

Leaves in Acotyledons. In Acotyledons the leaves vary much, being entire or divided, stalked or sessile, often feather-veined, occasionally with radiating venation, the extremities of the veins being forked. In Ferns the leaf (frond) is usually stalked, with frequently a much-divided lamina, remarkable for the prolonged growth at the apex, and in the young state usually covered with curious flattened hairs (*paleæ*). In Equisetaceæ the leaves are sheathing cylinders embracing successive internodes of the stem, and subsequently splitting at the top into few or many teeth. In Lycopodiaceæ the leaves vary from mere rudimentary scales, as in Psilotum, to the flattened acuminate leaf of Selaginella, with only a single fibro-vascular bundle, and then to the more complicated form in Isoetes, in which the longest leaves in the order occur, and these have a sheathing basal part and an upper lamina. On the face of the sheathing part is a depression or *fovea*, in which rests the sporangium, the margin of it rising as a thin membranous outgrowth, the *velum*. Above the fovea, and separated from it by a saddle-like ridge, lies a smaller depression the *foveola*, the lower margin of which forms a lip, the *labium*, and from its bottom is prolonged beyond the foveola an apiculate membranous structure, which is termed the *ligule*. In Mosses we have the simplest form of leaf, composed of one or more layers of cells, sometimes the central ones being more or less compacted and forming a median vein.

Phyllotaxis. Leaves occupy various positions on the stem and branches, and have received different names according to their situation. Thus leaves arising from the crown of the root, as in the Primrose, are called *radical*; those on the stem are *cauline*; on the branches, *ramal*; on flower-stalks, *floral* leaves. The first leaves developed are denominated *seminal* leaves or *cotyledons*, and those which succeed are *primordial*. The arrangement of the leaves on the axis and its appendages is called *phyllotaxis*. In their arrangement leaves follow a definite order. It has been stated already that there are regular *nodes* or points on the stem at which leaves appear, and that the part of the stem between the nodes is the *internode*. Each node is capable of giving origin to a leaf. Occasionally several nodes are approximated so as to form as it were one, and then several leaves may be produced at the same height on the stem. When two leaves are thus produced, one on each side of the stem or axis, and at the same level, they are called *opposite* (fig. 126); when more than two are produced (fig. 127), they are *verticillate*, and the circle of leaves is then called a *verticil* or *whorl*. When the zone of the axis which produces the circle of leaves is transverse from its origin, the whorl is a *true* one; but when the zone is the result of unequal development or of displacement the whorl is *spurious*. Again, in each whorl the leaves may be all

formed together, and a *simultaneous* whorl results; or they may be formed one after the other, as in Characeæ, when a *successive* whorl is formed. When leaves are opposite, each successive pair may be placed at right angles to the pair immediately preceding. They are then said to *decussate*, following thus a law of alternation. The same occurs

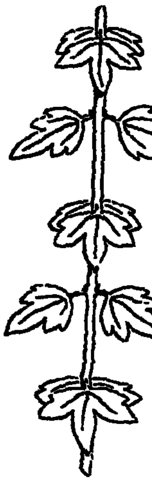


Fig. 126.

Fig. 127.

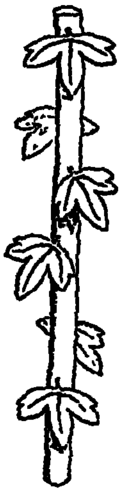


Fig. 128.

FIG 126.—A stem with opposite leaves The pairs are placed at right angles alternately, or in what is called a decussate manner. In the lowest pair one leaf is in front and the other at the back; in the second pair the leaves are placed laterally, and so on.

FIG 127—Verticillate or whorled leaves of a species of Madder There are five leaves in the verticil or whorl.

FIG 128.—A stem with alternate leaves, arranged in a pentastichous or quincuncial manner. The sixth leaf is directly above the first, and commences the second cycle. The fraction of the circumference of the stem expressing the divergence of the leaves is two-fifths.

in the verticillate arrangement, the leaves of each whorl rarely being *superposed* on those of the whorl next it, as on the branches of Chara, but usually alternating so that each leaf in a whorl occupies the space between two leaves of the whorl next to it. There are considerable irregularities, however, in this respect, and the number of leaves in different whorls is not always uniform, as may be seen in Lysimachia vulgaris. When a single leaf is produced at a node, and the nodes are separated so that each leaf is placed at a different height on the stem, the leaves are *alternate* (fig. 128). A plane passing through the point of insertion of the leaf in the node, dividing the leaf into two similar halves, is the median plane of the leaf; and when the leaves are arranged alternately on an axis so that their median planes coincide they form a straight row or *orthostichy* On every axis there are usually two or more orthostichies. The leaves in such a case are said to be rectiserial. In fig. 129, leaf 1 arises from a node *n*; leaf 2 is separated by

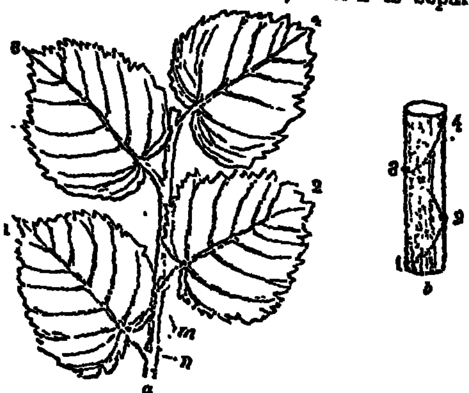


Fig. 129.

Portion of a branch of a Lime tree, with four leaves arranged in a distichous manner, or in two rows *a*, the branch with the leaves numbered in their order *n* being the node, and *m* the internode or merithal; *b* is a magnified representation of the branch, showing the cicatrices of the leaves and their spiral arrangement, which is expressed by the fraction ½ or one turn of the spiral for two internodes.

an internode *m*, and is placed to the right or left; while leaf 3 is situated directly above leaf 1. In this case, then, there are two orthostichies, and the arrangement is said to be *distichous*. When the fourth leaf is directly above the first, the arrangement is *tristichous*. The same arrangement continues throughout the branch, so that in the latter case the 7th leaf is above the 4th, the 10th above the 7th; also the 5th above the 2d, the 6th above the 3d, and so on. The size of the angle between the median planes of two consecutive leaves in an alternate arrangement is their *divergence*; and it is expressed in fractions of the circumference of the axis which is supposed to be a circle. In a regularly-formed straight branch covered with leaves, if a thread is passed from one to the other, turning always in the same direction, a spiral is described, and a certain number of leaves and of complete turns occur before reaching the leaf directly above that from which the enumeration commenced. If this arrangement is expressed by a fraction, the numerator of which indicates the number of turns, and the denominator the number of internodes in the spiral cycle, the fraction will be found to represent the angle of divergence of the consecutive leaves on the axis. Thus, in fig. 130, *a*, *b*, the cycle consists of five leaves, the 6th leaf being placed vertically over the 1st, the 7th over the 2d, and so on; while the number of turns between the 1st and 6th leaf is two; hence this arrangement is indicated by the fraction $\frac{2}{5}$. In other words, the distance or divergence between the first and second leaf, expressed in parts of a circle, is $\frac{2}{5}$ of a circle, or $360° \div \frac{2}{5} = 144°$. In fig. 129, *a*, *b*, the spiral is $\frac{1}{2}$, *i.e.*, one turn and two leaves; the third leaf being placed vertically over the first, and the divergence between the first and second leaf being one-half the circumference of a circle, $360° \div \frac{1}{2} = 180°$. Again, in a tristichous arrangement the number is $\frac{1}{3}$, or one turn and three leaves, the angular divergence being 120°.

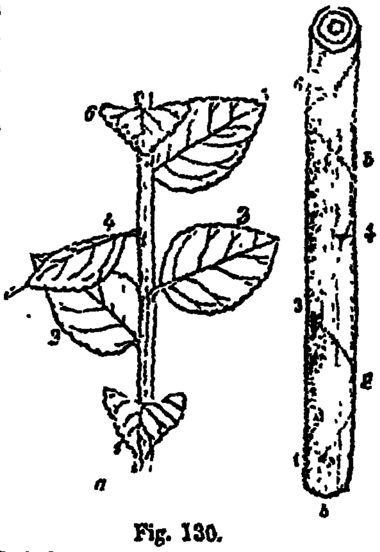


Fig. 130.

Part of a branch of a Cherry with six leaves, the sixth being placed vertically over the first, after two turns of the spiral. This is expressed by two-fifths, or the quincunx. *a*, the branch, with the leaves numbered in order; *b*, a magnified representation of the branch, showing the cicatrices of the leaves or their points of insertion, and their spiral arrangement.

By this means we have a convenient mode of expressing on paper the exact position of the leaves upon an axis. And in many cases such a mode of expression is of excellent service in enabling us readily to understand the relations of the leaves. The divergences may also be represented diagrammatically on a horizontal projection of the vertical axis, as in fig. 131. Here the outermost *circle* represents a section of that portion of the axis bearing the lowest leaf, the innermost represents the highest. The broad dark lines represent the leaves, and they are numbered according to their age and position. It will

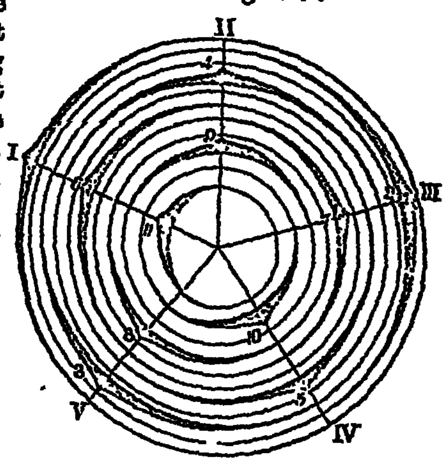


Fig. 131.

Diagram of a phyllotaxis represented by the fraction 2-5ths. (*Sachs.*)

be seen at once that the leaves are arranged in orthostichies marked I.–V., and that these divide the circumference into five equal portions. But the divergence between leaf 1 and leaf 2 is equal to $\frac{2}{5}$ths of the circumference, and the same is the case between 2 and 3, 3 and 4, &c. The divergence, then, is $\frac{2}{5}$, and from this we learn that, starting from any leaf on the axis, we must pass twice round the stem in a spiral through five leaves before reaching one directly over that with which we started. When the leaves or scales are alternate, and run in a single series, they are *unijugate;* when the leaves are opposite, and there are two series, the arrangement is *bijugate;* while in the case of whorled leaves the arrangement may be *trijugate* or *quadrijugate.* The line which, winding round an axis either to the right or to the left, passes through the points of insertion of all the leaves on the axis is termed the *genetic* or *generating spiral;* and that margin of each leaf which is towards the direction from which the spiral proceeds is the *kathodic* side, the other margin facing the point whither the spiral passes being the *anodic* side.

In cases where the internodes are very short, and the leaves are closely applied to each other, as in the House-leek, it is difficult to trace the *generating spiral.* Thus, in fig. 132 there are thirteen leaves which are numbered in their order, and five turns of the spiral marked by circles in the centre

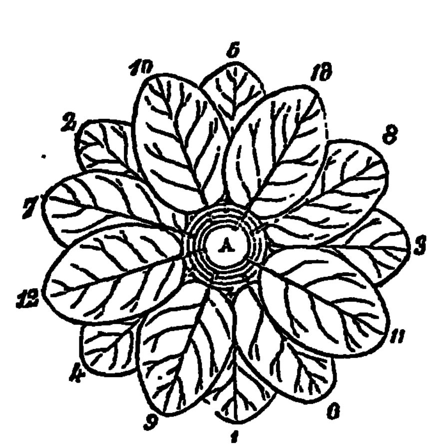


Fig. 132.

Fig. 133.

FIG. 132.—Cycle of thirteen leaves placed closely together so as to form a rosette. as in Sempervivum. A is the very short axis to which the leaves are attached, The leaves are numbered in their order, from below upwards. The circles in the centre indicate the five turns of the spiral, and show the insertion of each of the leaves. The divergence is expressed by the fraction 5-13ths.

FIG. 133.—Cone of *Abies alba* with the scales or modified leaves numbered in the order of their arrangement on the axis of the cone. The lines indicate a rectilinear series of scales, and two lateral secondary spirals, one turning from left to right, the other from right to left.

($\frac{5}{13}$ indicating the arrangement); but this could not be detected at once. So also in Fir cones (fig. 133), which are composed of scales or modified leaves, the generating spiral cannot be determined easily. But in such cases a series of *secondary spirals* or *parastichies* are seen running parallel with each other both right and left, which to a certain extent conceal the genetic spiral. Thus, in fig. 133, it will be found that there are five secondary spirals running towards the right and parallel to each other, the first passing through the scales 1, 6, 11, 16, &c.; the second through 9, 14, 19, 24, &c.; the third through 17, 22, 27, 32, 37, &c.; the fourth through 30, 35, 40, 45, &c.; the fifth through 43, 48, 53, &c. The number of these secondary spirals indicates the number of scales intervening between every two scales in each of these spirals, the common difference being five. Again, it will be found on examination that there are secondary spirals running to the left, in which the common difference between every two scales is eight, and that this corresponds to the number of secondary spirals, the first of which passes through the scales 1, 9, 17, &c.; the second through 6, 14, 22, 30, &c.; the third through 3, 11, 19, 27, 35, 43, and so on. Thus it is that, by counting the secondary spirals, all the scales may be numbered, and by this means the generating spiral may be discovered. From the number of secondary spirals the angle of divergence may be easily calculated, the sum of those which wind in both directions giving the denominator of the fraction, while the smaller of the two numbers representing those winding in each direction is the numerator. Thus in the instance last mentioned the angular divergence is $\frac{5}{13}$. In the cone of the American larch (fig. 134) there is a quincuncial arrangement of scales marked by the fraction $\frac{2}{5}$. There are five vertical ranks, as marked in the tabular numerical view at the side of the cone, which represents the unwound surface of the cone, viz., 2, 7, 12; 4, 9, 14; 1, 6, 11; 3, 8, 13; 5, 10, 15,—the common difference in each row being 5. On looking at the cone we find also parallel oblique ranks, two of which, ascending to the left, are marked by the numbers 1, 3, 5, which, if the diagram is coiled round a cylinder, continue in the numbers 7, 9, 11, 13, 15; and 2, 4, 6, 8, 10, continued into 12, 14. There are thus two left-handed spirals, with 2 as the common difference in the numbering of the scales. Again, three oblique parallel spirals ascend to the right, marked by the numbers 1, 4, 7, running into 10, 13; 3, 6, 9, 12, going on to 15; and 5, 8, 11, 14; here the common difference in the numbering of the scales is 3, corresponding with the oblique right-handed spirals.

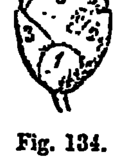
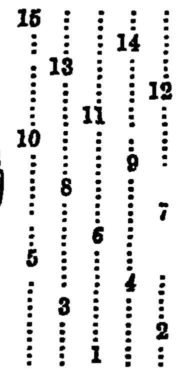


Fig. 134.



Cone of a species of Larch (*Larix microcarpa*). The surface of the cone is supposed to be unwound and the scales numbered so far as seen. The arrangement is 2-5ths, in the five-ranked series.

All the constant divergences found in phyllotaxis may be represented as successive convergents of the continued fraction

$$\frac{1}{a + 1 + 1 + 1 + 1, \&c.,}$$

where a may have the values 1, 2, 3, 4, &c.

The actual fractions thus resulting are—

$$\begin{aligned} \text{when } a &= 1, \ldots \tfrac{1}{2},\ \tfrac{2}{3},\ \tfrac{3}{5},\ \tfrac{5}{8},\ \tfrac{8}{13},\ \&c. \\ a &= 2, \ldots \tfrac{1}{2},\ \tfrac{1}{3},\ \tfrac{2}{5},\ \tfrac{3}{8},\ \tfrac{5}{13},\ \&c. \\ a &= 3, \ldots \tfrac{1}{3},\ \tfrac{1}{4},\ \tfrac{2}{7},\ \tfrac{3}{11},\ \tfrac{5}{18},\ \&c. \\ a &= 4, \ldots \tfrac{1}{4},\ \tfrac{1}{5},\ \tfrac{2}{9},\ \tfrac{3}{14},\ \tfrac{5}{23},\ \&c. \end{aligned}$$

The spiral is not always constant throughout the whole length of an axis. The angle of divergence may alter either abruptly or gradually, and the phyllotaxis thus becomes very complicated. This change may be brought about by arrest of development, by increased development of parts, or by a torsion of the axis. The former are exemplified in many Crassulaceæ and Aloes. The latter is seen well in the Screw pine (Pandanus). In the bud of the screw pine the leaves are arranged in three orthostichies with the phyllotaxis $\frac{1}{3}$, but by torsion the developed leaves become arranged in three strong spiral rows running round the stem. These causes of change in phyllotaxis are also well exemplified in the alteration of an opposite or verticillate arrangement to an alternate, and *vice versa;* thus the effect of interruption of growth, in causing alternate leaves to become opposite and verticillate, can be distinctly shown in Rhododendron ponticum. Again, parts which are usually opposite or verticillate become alternate by the vigorous development of the axis, as in Hippuris, and also in Lysimachia vulgaris, where on different parts of the same stem there may be seen alternate, opposite, and

verticillate leaves. When the interruption to development takes place at the end of a branch, the leaves become *fasciculate* or clustered, as in the Larch. The primitive or generating spiral may pass either from right to left or from left to right. It sometimes follows a different direction in the branches from that pursued in the stem. When it follows the same course in the stem and branches, they are *homodromous;* when the direction differs, they are *heterodromous.* In different species of the same genus the phyllotaxis frequently varies.

All modifications of leaves follow the same laws of arrangement as true leaves—a fact which is of importance in a morphological point of view. In Dicotyledonous plants the first leaves produced (the cotyledons) are opposite, in some cases verticillate. This arrangement often continues during the life of the plant, but at other times it changes, passing into distichous and spiral forms. Some tribes of plants are distinguished by their opposite or verticillate, others by their alternate, leaves. Labiate plants have decussate leaves, while Boraginaceæ have alternate leaves, and Tiliaceæ usually have distichous leaves; Cinchonaceæ have opposite leaves; Galiaceæ, verticillate. Such arrangements as $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, and $\frac{8}{21}$ are common in Dicotyledons. The first of these, called a *quincunx,* is met with in the Apple, Pear, and Cherry (fig. 130); the second, in the Bay, Holly, Plantago media; the third, in the cones of Pinus (Abies) alba (fig. 133); and the fourth in those of the Pinus (Abies) Picea. In Monocotyledonous plants there is only one seed-leaf or cotyledon produced, and hence the arrangement is at first alternate; and it generally continues so more or less, rarely being verticillate. Such arrangements as $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{2}{5}$ are common in Monocotyledons, as in Grasses, Sedges, and Lilies. In Acotyledons the leaves assume all kinds of arrangement, being opposite, alternate, and verticillate. It has been found in general that, while the number 5 occurs in the phyllotaxis of Dicotyledons, 3 is common in that of Monocotyledons.

In the axil of previously formed leaves leaf-buds arise. These *leaf-buds* contain the rudiments of a *shoot,* and consist of leaves covering a growing point. The buds of trees of temperate climates, which lie dormant during the winter, are protected by cataphyllary leaves constituting the *tegmenta* or *perulæ.* These scales or protective appendages of the bud consist either of the altered laminæ, or of the enlarged petiolary sheath, or of stipules, as in the Fig and Magnolia, or of one or two of these parts combined. These are often of a coarse nature, serving a temporary purpose, and then falling off when the leaf is expanded. They are frequently covered with a resinous matter, as in Balsam-poplar and Horse-chestnut, or by a thick downy covering as in the Willow. In plants of warm climates the buds have often no protective appendages, and are then said to be *naked.*

Vernation.

The arrangement of the leaves in the bud has been denominated *vernation, præfoliation,* and *gemmation.* In considering vernation we must take into account both the manner in which each individual leaf is folded and also the arrangement of the leaves in relation to each other. These vary in different plants, but in each species they follow a regular law. The leaves in the bud are either placed simply in apposition, as in the Mistleto, or they are folded or rolled up longitudinally or laterally, giving rise to different kinds of vernation, as delineated in figs. 135 to 144, where the folded or curved lines represent the leaves, the thickened part being the midrib. The leaf taken individually is either folded longitudinally from apex to base, as in the Tulip-tree, and called *reclinate* or *replicate;* or rolled up in a circular manner from apex to base, as in Ferns (fig. 135), and called *circinate;* or folded laterally, *conduplicate* (fig. 136), as in Oak; or it has several folds like a fan, *plicate* or *plaited* (fig. 137), as in Vine and Sycamore, and in leaves with radiating vernation, where the ribs mark the foldings; or it is rolled upon itself, *convolute* (fig. 138), as in Banana and Apricot; or its edges are rolled inwards, *involute* (fig. 139), as in Violet; or outwards, *revolute* (fig. 140), as in Rosemary. The different divisions of a cut

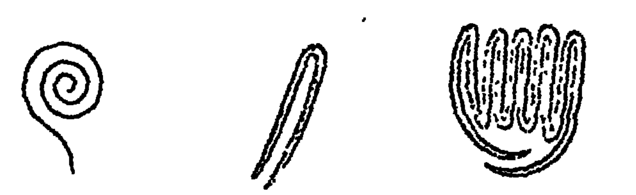


Fig. 135. Fig. 136. Fig. 137.

Fig. 138. Fig. 139. Fig. 140.

Fig. 135.—Circinate vernation.
Fig. 136.—Transverse section of a conduplicate leaf.
Fig. 137.—Transverse section of a plicate or plaited leaf.
Fig. 138.—Transverse section of a convolute leaf.
Fig. 139.—Transverse section of an involute leaf.
Fig. 140.—Transverse section of a revolute leaf.

leaf may be folded or rolled up separately, as in Ferns, while the entire leaf may have either the same or a different kind of vernation. The leaves have a definite relation to each other in the bud, being either opposite, alternate, or verticillate; and thus different kinds of vernation are produced. Sometimes they are nearly in a circle at the same level, remaining flat, or only slightly convex externally, and placed so as to touch each other by their edges, thus giving rise to *valvate* vernation. At other times they are at different levels, and are applied over each other, so as to be *imbricated,* as in Lilac, and in the outer scales of Sycamore (fig. 63); and occasionally the margin of one leaf overlaps that of another, while it in its turn is overlapped by a third, so as to be *twisted, spiral,* or *contortive.* When leaves are applied to each other face to face, without being folded or rolled together, they are *appressed.* When the leaves are more completely folded they either touch at their extremities and are *accumbent* or *opposite* (fig. 141), or are folded inwards by their margin, and become *induplicate;* or a conduplicate leaf covers another similarly folded, which in turn covers a third, and thus the vernation is *equitant* (fig. 142), as in Privet; or conduplicate leaves are placed so that the half of the one covers the half

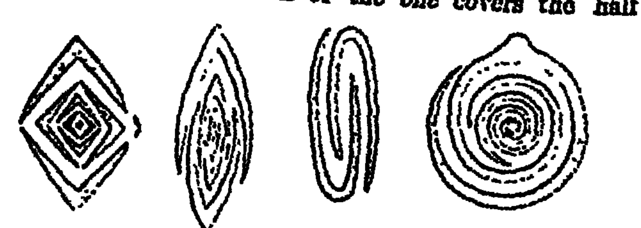


Fig. 141. Fig. 142. Fig. 143. Fig. 144.

Fig. 141.—Transverse section of a bud, in which the leaves are arranged in an accumbent manner.
Fig. 142.—Transverse section of a bud, in which the leaves are arranged in an equitant manner.
Fig. 143.—Transverse section of a bud, showing two leaves folded in an obvolute manner. Each is conduplicate, and one embraces the edge of the other.
Fig. 144.—Transverse section of a bud, showing two leaves arranged in a supervolute manner.

of another, and thus they become *half-equitant* or *obvolute* (fig. 143), as in Sage. When in the case of convolute leaves one leaf is rolled up within the other, it is *supervolute* (fig. 144). The scales of a bud sometimes exhibit one kind of vernation, and the leaves another. The same modes of arrangement occur in the flower-buds, as will be afterwards shown.

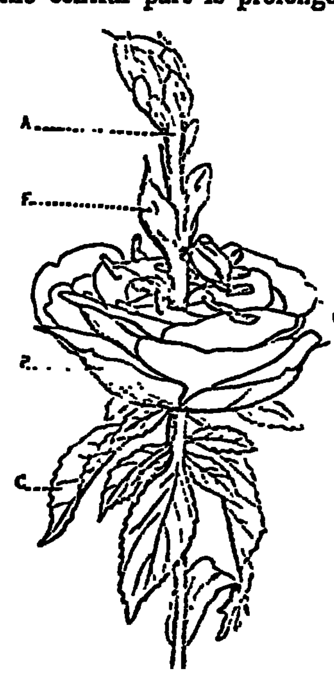
Leaves expose the fluids of plants to the influence of air

and light. The fluids so exposed are elaborated. and thus fitted for the formation of the various vegetable tissues and secretions. For the proper performance of this function the structure of the leaves, and their arrangement on the stem and branches, render them well adapted. The cells in the lower side of a leaf where stomata exist are chiefly concerned in the aeration of the sap, whilst other assimilative processes go on in the upper cells. The elaboration of fluids in the leaves necessarily implies interchange of their constituents with those of the surrounding atmosphere; hence two processes are inevitable—a passing inwards into the leaf of the atmospheric elements by a *process of absorption*, and an outward current of the components of the plant-juices by a *process of exhalation.* The absorption of carbonic acid, water, and other fluids is carried on by the leaves, chiefly through their stomata, and most rapidly by the under surface of ordinary leaves in which the cuticle is thinnest, the cellular tissue least condensed, and stomata most abundant; the upper surface of the leaf, which usually presents a polished and dense epidermis with few stomata, taking little part in such a process. An exhalation of both liquids and gases also takes place from the leaves, regulated by the number and the size of stomata as well as by the nature of the epidermis. The process of *transpiration* of fluids imparts moisture to the atmosphere, and hence the difference between the air of a wooded country and that of a country deprived of forests. Thus leaves have an important influence upon the climate of a country. In darkness little or no transpiration takes place, and in diffuse daylight it is less than in the sun's rays. The exhalation of gases constitutes the process of *respiration.* The nature and amount of the gases respired depends both on the circumstances in which the leaves are placed and on the condition of the plant. But normally at all times there seems to be a respiration of carbonic acid, which, under the influence of light, is at once decomposed by the green parts of the plant, the carbon being fixed and the oxygen set free; consequently, in darkness no oxygen is eliminated. Leaves, after performing their functions for a certain time, wither and die. In doing so they frequently change colour, and hence arise the beautiful and varied tints of the autumnal foliage. This change of colour is chiefly occasioned by the diminished circulation in the leaves, and the higher degree of oxidation to which their chlorophyll has been submitted.

Leaves which are articulated with the stem, as in the Walnut and Horse-chestnut, fall and leave a scar, while those which are continuous with it remain attached for some time after they have lost their vitality, as in the Beech. Most of the trees of Great Britain have deciduous leaves, their duration not extending over more than a few months, while in trees of warm climates the leaves often remain for two or more years. In tropical countries, however, many trees lose their leaves in the dry season. The period of defoliation varies in different countries according to the nature of their climate. Trees which are called evergreen, as Pines and Evergreen-oak, are always deprived of a certain number of leaves at intervals, sufficient being left, however, to preserve their green appearance. The cause of the fall of the leaf in cold climates seems to be deficiency of light and heat in winter, which causes a cessation in the functions of the cells of the leaf; its fluids disappear by evaporation; its cells and vessels become contracted and diminished in their calibre; various inorganic matters accumulate in the textures; the whole leaf becomes dry; its parts lose their adherence; a process of disjunction takes place by a folding inwards of the tissue at the point where the leaf joins the stem or branch which gradually extends until complete separation takes place, and the leaf either falls by its own weight or is detached by the wind. In warm climates the dry season gives rise to similar phenomena.

II. ORGANS OF REPRODUCTION.

We now proceed to pass in review the reproductive organs of plants. In Phanerogamous plants, as already mentioned, these organs are conspicuous, and constitute what is known as the flower; in Cryptogamous plants they are inconspicuous. All Dicotyledonous and Monocotyledonous plants are included in the former; Acotyledonous and Thallogenous plants compose the latter. The structures which go to form these organs are not, however, formations of a new type, but are merely modifications of those structures which we have already considered under the nutritive organs. For example, the various parts of the flower in Phanerogams are really phyllomes, the supporting structures of the flower are caulomes, the spore-bearing sac of many Cryptogams is a trichome; and in this way a morphological equivalency may be traced betwixt the two series of organs. Further, the difference betwixt the reproductive organs of Phanerogams and those of Cryptogams is one more of degree of differentiation than of actual morphological difference. In Phanerogams the flowers or floral axes are produced from flower-buds, just as leaf-shoots arise from leaf-buds. These two kinds of buds have a resemblance to each other as regards the arrangement and the development of their parts; and it sometimes happens, from injury and other causes, that the part of the axis which, in ordinary cases, would produce a leaf-bud, gives origin to a flower-bud. A flower-bud has not in ordinary circumstances any power of extension by the development of its central cellular portion. In this respect it differs from a leaf-bud. In some cases, however, of monstrosity, especially seen in the Rose (fig. 145) and Geum, the central part is prolonged, and bears leaves or flowers. In such cases the flowers, so far as their functional capabilities are concerned, are usually abortive.



Flower-buds, like leaf-buds, are produced in the axil of leaves, which are called *floral* leaves, *bracts*, or *hypsophyllary* leaves.

The term *bract* is properly applied to the leaf from which the primary floral axis, whether simple or branched, arises, while the leaves which arise on the axis between the bract and the outer envelope of the flower are *bracteoles* or *bractlets.* Bracts sometimes do not differ from the ordinary leaves, and are then called *leafy*, as in Veronica hederifolia, Vinca, Anagallis, and Ajuga. Like leaves they are entire or divided. In general as regards their form and appearance, they differ from ordinary leaves, the difference being greater in the upper than in the lowe[r] They are distinguished by th[e] flower or flower-stalk. The[i] of the leaf. When the flowe[r]

applied closely to the calyx, and may thus be confounded with it, as in Malvaceæ and species of Dianthus and Eranthis, where they have received the name of *epicalyx* or *calyculus*. In some Rosaceous plants an epicalyx is present, due to the formation of stipulary structures by the sepals. In many cases bracts seem to perform the function of protective organs, within or beneath which the young flowers are concealed in their earliest stage of growth.

When bracts become coloured, as in Amherstia nobilis, Euphorbia splendens, Erica elegans, and Salvia splendens, they may be mistaken for parts of the corolla. They are sometimes mere scales or threads, and at other times they are abortive, and remain undeveloped, giving rise to the *ebracteated* inflorescence of Cruciferæ and some Boraginaceæ. Sometimes no flower-buds are produced in their axil, and then they are *empty*. A series of empty coloured bracts terminates the inflorescence of Salvia Horminum. The smaller bracts or bracteoles, which occur among the subdivisions of a branching inflorescence, often produce no flower-buds, and thus anomalies occur in the floral arrangements. Bracts are occasionally persistent, remaining long attached to the base of the peduncles, but more usually they are deciduous, falling off early by an articulation. In some instances they form part of the fruit, becoming incorporated with other organs. Thus, the cones of Firs and the strobili of the Hop are composed of a series of bracts arranged in a spiral manner, and covering fertile flowers; and the scales on the fruit of the Pine-apple are of the same nature. In amenta or catkins the bracts are called *squamæ* or scales. At the base of the general umbel in Umbelliferous plants, a whorl of bracts often exists, called a *general involucre*, and at the base of the smaller umbels or umbellules there is a similar leafy whorl called *involucel* or *partial involucre*. In some instances, as in Fool's-parsley, there is no general involucre, but simply an involucel; while, in other cases, as in Fennel, neither involucre nor involucel is developed. In Compositæ the name involucre is applied to the leaves, scales, or *phyllaries*, surrounding the head of flowers (fig. 146, *i*), as in Dandelion, Daisy, Artichoke. This involucre is frequently composed of several rows of leaflets, which are either of the same or of different forms and lengths, and often lie over

Plate VII.

Plate IX

Fig. 146.

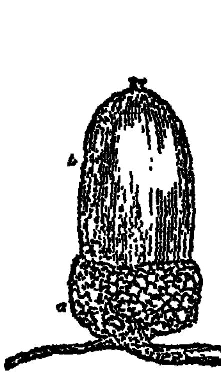


Fig. 147.

FIG. 146.—Head (capitulum) of Marigold (*Calendula*), showing a congeries of flowers, enclosed by *rows* of bracts or phyllaries, *i*, at the base, which are collectively called an involucre.
FIG. 147.—Fruit of the Oak (*Quercus pedunculata*), showing a collection of bracts, *a*, forming the cup (cupula) of the acorn *b*.

each other in an imbricated manner. When the bracts are arranged in two rows, and the outer row is perceptibly smaller than the inner, the involucre is sometimes said to be *caliculate*, as in Senecio. The leaves of the involucre are spiny in Thistles and in Dipsacus, and hooked in Burdock. Such whorled or verticillate bracts may either remain separate (*polyphyllous*), or may be united by cohesion (*gamophyllous*), as in many species of Bupleurum, and in Lavatera. In Compositæ besides the general envelope called the involucre, there are frequently *chaffy* and *setose* bracts at the base of each flower, and in Dipsacaceæ a membranous tube surrounds each flower. These structures are of the nature of an epicalyx. In the acorn the *cupula* or cup (fig. 147, *a*) is formed by a growing upwards of the flower-stalk immediately beneath the flower, upon which scaly or spiny protuberances appear. It is of the nature of bracts. Bracts also compose the husky covering of the Hazel-nut. In the Yew the succulent covering of the seed is by some considered to be formed by the bracts.

When bracts become united together, and overlie each other in several rows, it often happens that the outer ones do not produce flowers, that is, are empty or sterile. In the Artichoke the outer imbricated scales or bracts are in this condition, and it is from the membranous white scales or bracts (*paleæ*) forming the choke attached to the edible receptacle that the flowers are produced. The sterile bracts of the Daisy occasionally produce *capitula*, and give rise to the Hen-and-Chickens Daisy. In place of developing flower-buds, bracts may, in certain circumstances, as in *proliferous* or *viviparous* plants, produce leaf-buds, and the flower-buds, like the leaf-buds, may be *terminal* or they may be *lateral*.

A sheathing bract enclosing one or several flowers is called a *spatha* or *spathe*. It is common among Monocotyledons, as Narcissus (figure 148), Snow-flake, Arum, and Palms. In some Palms it is 20 feet long, and encloses 200,000 flowers. It is often associated with that form of inflorescence termed the *spadix*, and may be coloured, as in Richardia æthiopica, sometimes called the Æthiopian- or Trumpet Lily. When the spadix is compound or branching, as in Palms, there are smaller spathes, surrounding separate parts of the inflorescence, to which the name *spathellæ* has sometimes been given. The spathe protects the flowers in their young state, and often falls off after they are developed, or hangs down in a withered form, as in some Palms, Typha, and Pothos. In Grasses the outer scales of the spikelets have been considered as sterile bracts, and have received the name of *glumes* (fig. 149, *gl*), and in Cyperaceæ bracts enclose the organs of reproduction. Bracts are frequently changed into complete leaves. This change is called phyllody of bracts. It is seen in species of Plantago, especially in the variety of Plantago media, called the Rose-plantain in gardens. In this plant the bracts become leafy, and form a rosette round the flowering axis. Similar changes occur in Plantago major, P. lanceolata, Ajuga reptans, the Dandelion, the Daisy, the Dahlia, and in Umbelliferous plants. The conversion of bracts into stamens has been observed in the case of Abies excelsa. This has been called staminody of bracts. A lengthening of the axis of the female strobilus of Coniferæ is not of infrequent occurrence in Cryptomeria japonica, Larix europæa, &c., and this is usually associated with a leaf-like condition of the bracts, and sometimes even with the development of leaf-bearing shoots in place of the scales.

Plate XVI

Fig. 148.

Flowers of Polyanthus Narcissus (*Narcissus Tazetta*) bursting from a sheathing bract *b*.

The arrangement of the flowers on the axis, or the ramification of the floral axis, is called *inflorescence* or *anthotaxis*. The primary axis of inflorescence is sometimes called *rachis;* its branches, whether terminal or lateral, which form the stalks supporting flowers or clusters of flowers, are *peduncles*, and if small branches are given off by it, they are called *pedicels*. A flower having a stalk is called *pedunculate* or *pedicellate;* one having no stalk is *sessile*. In describing a branching inflorescence, it is common to speak of the rachis as the *primary* floral axis, its branches as the *secondary* floral axes, their divisions as the *tertiary* floral axes, and so on; thus avoiding any confusion that might arise from the use of the terms *rachis*, *peduncle*, and *pedicel*.

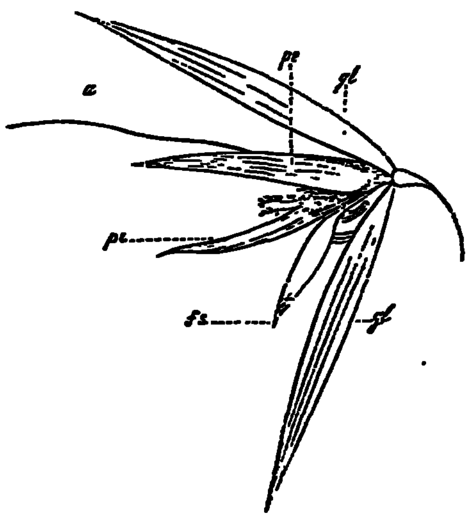


Fig. 149.

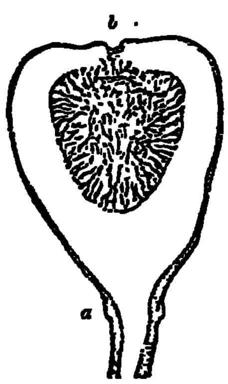


Fig. 150.

FIG. 149.—Spikelet of Oat (*Avena sativa*) laid open, showing the bracts *gl*, *gl*, which are denominated empty glumes; *pe*, the outer pale or glumellule (floral glume), with a dorsal awn *a*; *pi*, the inner pale; *fs*, an abortive flower.
FIG. 150.—Peduncle, *a*, of Fig (*Ficus Carica*), ending in a hollow receptacle *b*, enclosing numerous male and female flowers.

uncle. The *peduncle* may be cylindrical, compressed, or grooved; simple, bearing a single flower, as in Primrose; or branched, as in London-pride. It is sometimes succulent, as in the te IV. Cashew, in which it forms the large coloured expansion supporting the nut; spiral, as in Cyclamen and Vallisneria; or spiny, as in Alyssum spinosum. In some Rushes there is a green terete, and sometimes spiral, floral axis. Sometimes the peduncle proceeds from radical leaves, that is, from an axis which is so shortened as to bring the leaves close together in the form of a cluster, as in the Primrose, Auricula, Hyacinth, &c. In such cases it is termed a *scape*. The floral axis may be shortened, assuming a flattened, convex, or concave form, and bearing numerous flowers, as in the Artichoke, Daisy, and Fig (fig. 150). In these cases it is called a *receptacle* or *phoranthium* or *clinanthium*. The floral axis sometimes assumes a leaf-like or *phylloid* appearance, bearing numerous flowers at its margin, as in Xylophylla longifolia and in Ruscus; or it appears as if formed by several peduncles united together, constituting a fasciated axis, as in the Cockscomb, in which the flowers form a peculiar crest at the apex of the flattened peduncles. Adhesions occasionally take place between the peduncle and the bracts or leaves of the plant, as in the Lime-tree (fig. 151), Helwingia, Chailletia, several species of Hibiscus, and Zostera. The adhesion of the peduncles to the stem accounts for the extra-axillary position of flowers, as in many Solanaceæ. When this union extends for a considerable length along the stem, several leaves may be interposed between the part where the peduncle becomes free and the leaf whence it originated, and it may be difficult to trace the connection. The peduncle occasionally becomes abortive, and in place of bearing a flower, is transformed into a tendril; at other times it is hollowed at the apex, so as apparently to form the lower part of the outer whorl of floral leaves as in Eschscholtzia. The termination of the Plate II.

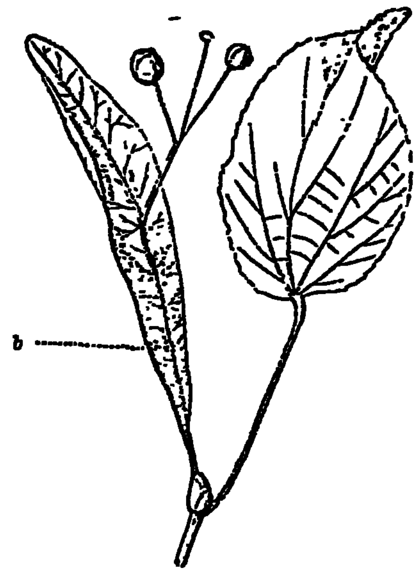


Fig. 151.

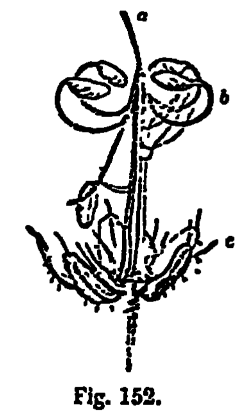
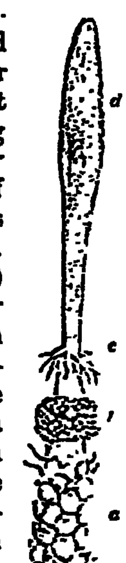


Fig. 152.

FIG. 151.—Leaf and flowering branch of the Lime-tree (*Tilia*). The bract *b* is adherent to the peduncle or flower-stalk. The flowers are arranged in a corymbose cyme.
FIG. 152.—The calyx and beak-like process of Geranium, with the parts of the pistil (the carpels) curled upwards, so as to scatter the seed. *a*, the extremity of the rostrum or beak, whence the name crane's bill is derived; *b*, the carpels curled up by means of the styles which are attached to the beak; *c*, the calyx.

peduncle, or the part on which the whorls of the flower are arranged, is called the *thalamus* or *torus*. The term *receptacle* is also sometimes applied to this, whether expanded and bearing several flowers, or narrowed so as to bear one. It may be considered as the growing point of the axis, which usually is arrested by the production of the flowers, but which sometimes becomes enlarged and expanded. Thus, in the Geranium (fig. 152) it is prolonged beyond the flower in the form of a beak (*rostrate*); in the Arum (fig. 153) it is a club-shaped fleshy column; in the Strawberry (fig. 154) it becomes a conical succulent mass, on which the seed-vessels are placed; while in Nelumbium it forms a truncated tabular top-like expansion (*turbinate*), enveloping the seed-vessels. The margins of the receptacle may grow up whilst the centre remains depressed, and thus a concave torus is formed, as in the Rose (fig. 155). In some monstrous flowers of the Rose and Geum it is prolonged as a branch bearing leaves. Peduncles and pedicels sometimes become remarkably elongated, and this elongation of the flower-stalks sometimes alters the general character of the inflorescence. We occasionally observe the heads of flowers of the common White Clover becoming racemose by the lengthening of the flower-stalks.



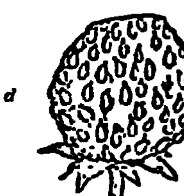


Fig. 154.

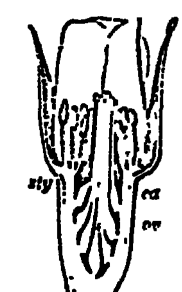


Plate XVI.

Fig. 153. Fig. 155.

FIG. 153.—Spadix of Cuckow-pint (*Arum maculatum*), consisting of numerous male flowers *b*, female *a*, and abortive flowers *c*, sessile on a succulent rachis, and enclosed in a spathe which in the figure has been removed. The rachis ends in a succulent club-shaped mass of cellular tissue, *d*.
FIG. 154.—Fruit of the Strawberry (*Fragaria vesca*), consisting of an enlarged succulent prolongation of the receptacle, bearing on its surface numerous carpels, which are often erroneously called seeds. The calyx is seen at the lower part.
FIG. 155.—The fruit of the Rose cut vertically. The receptacle lines the interior of the calyx *ca*, and the carpels with their ovaries *ov* and styles *sty* are attached to it. The stamens and petals are seen at the upper part attached to the calyx.

Inflorescence.

Before proceeding to an examination of the parts of the flower-bud, we will consider the various modes of arrangement of the flowers upon the axis, or the *inflorescence*.

We may recognize two distinct types of inflorescence—one in which the flowers always arise as lateral shoots from a primary axis, which goes on elongating, and the lateral shoots never exceed in their development the length of the primary axis beyond their point of origin. The flowers are thus always *axillary*. Exceptions, such as in Cruciferous plants, are due to the non-appearance of the bracts. In the other type the primary axis terminates in a single flower, but lateral axes are given off from the axil of bracts, which again repeat the primary axis, and the development of each lateral axis is stronger than the primary axis beyond its point of origin. The flowers produced in this inflorescence are thus *terminal*. The first kind of inflorescence is *indeterminate*, *indefinite*, or *axillary*. Here the axis is either elongated, producing flower-buds as it grows, the lower expanding first; or it is shortened and depressed, and the outer flowers expand first. The expansion of the flowers is thus *centripetal*, that is, from base to apex, or from circumference to centre. This kind of inflorescence is shown in fig. 156, where the leaf from which the cluster of flowers is produced, *f*, represents the bract or floral leaf. The *rachis*, or primary axis of the flower is *a′*; this produces small leaflets *b*, which bear smaller flower-leaves or bractlets, from which peduncles or secondary axes spring, each bearing single flowers. In fig. 157 the same kind of inflorescence is shown on a shortened axis, the outer flowers expanding first, and those in the centre last.

Fig. 156.

Fig. 157.

Fig. 156.—Raceme of Barberry (*Berberis vulgaris*) produced in the axil of a leaf or bract *f*, which has been transformed into a spine, with two stipules *s* at its base; *a′*, primary floral axis, bearing small alternate bracts *b*, in the axil of which the secondary axes *a″*, *a″* are produced, each terminated by a flower. The expansion of the flowers is centripetal, or from base to apex: the lower flowers have passed into the state of fruit, the middle are fully expanded, and those at the top are still in bud. Indeterminate simple inflorescence.
Fig. 157.—Head of flowers (capitulum) of Scabiosa atro-purpurea. The inflorescence is simple and indeterminate, and the expansion of the flowers centripetal, those at the circumference opening first.

flower *f‴*. From this tertiary axis a fourth is in progress of formation. Here *f′* is the termination of the primary axis, and this flower expands first, while the other flowers are developed centrifugally on separate axes.

A third series of inflorescences, termed *mixed*, may be recognized. In them the primary axis has an arrangement belonging to the opposite type from that on the branches, or *vice versa*. According to the mode and degree of development of the lateral shoots and also of the bracts, various forms of both inflorescences result.

Amongst indefinite forms the simplest occurs when a lateral shoot produced in the axil of a large single foliage leaf of the plant ends in a single flower, the axis of the plant elongating beyond, as in Veronica hederifolia, Vinca minor, and Lysimachia nemorum. The flower in this case is *solitary*, and the Inflorescence has been designated *solitary axillary*. The ordinary leaves in this case become floral leaves or bracts, by producing flower-buds in place of leaf-buds. The flowers, being all offshoots of the same axis, are said to be of the same generation or degree, and their number, like that of the leaves of this main axis, is indefinite, varying with the vigour of the plant. Usually, however, the floral axis, arising from a more or less altered leaf or bract, instead of ending in a solitary flower, is prolonged, and bears numerous leaflets, called *bracteoles* or *bractlets*, from which smaller peduncles are produced, and those again in their turn may be branched in a similar way. Thus the flowers are arranged in groups, and frequently very complicated forms of inflorescence result. When the primary peduncle or floral axis, as in fig. 156, *a′*, is elongated, and gives off pedicels *a″*, of nearly equal length ending in single flowers, a *raceme* or *cluster* is produced, as in Currant, Hyacinth, and Barberry. If the secondary floral axes give rise to tertiary ones, the raceme is branching, and forms what is by some called a *panicle*, as in Yucca gloriosa; but it is better to restrict this term to the lax inflorescence of some Grasses and Rushes. If in a raceme the lower flower-stalks are developed more strongly than the upper, and thus all the flowers are nearly on a level, a *corymb* is formed, which may be simple, as in fig. 159, where the primary axis *a′* divides into secondary axes *a″*, *a″*, which end in single flowers; or branching, where the secondary axes again subdivide. If the peduncles or secondary axes are very short or awanting, so that the flowers are sessile, a *spike* is produced, as in Plantago and Verbena officinalis (fig. 160). The spike sometimes bears unisexual flowers, usually staminiferous, the whole falling off by an articulation, as in Willow or Hazel (fig. 161), and then it is called an *amentum* or *catkin*, hence such trees are called *amentiferous*; at other times it becomes succulent, bearing numerous flowers, surrounded by a sheathing bract or spathe, and then it constitutes a *spadix*, which may be simple, as in Arum maculatum (fig. 153), or branching, as in Palms. Plate XVI.
A spike bearing female flowers only, and covered with scales, is either a *strobilus*, as in the Hop; or a *cone*, as in the Fir (fig. 133). It may be mentioned here that many do not consider the cone of Firs an axis of inflorescence,

Fig. 158.

Plant of *Ranunculus bulbosus*, showing determinate inflorescence.

but regard it as a single flower with the floral leaves placed at different heights. In Grasses there are usually numerous sessile flowers arranged in small spikes, called *locustæ* or

Fig. 159.

Fig. 160.

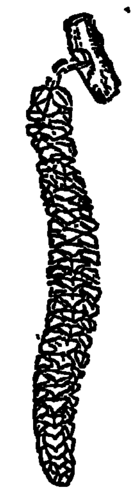


Fig. 161.

FIG. 159.—Corymb of *Cerasus Mahaleb*, produced in the axil of a leaf which has fallen, and terminating an abortive branch, at the base of which are modified leaves in the form of scales, *e*.

FIG. 160.—Spike of *Verbena officinalis*, showing sessile flowers on a common rachis. The flowers at the lower part of the spike have passed into fruit, those towards the middle are in full bloom, and those at the top are only in bud.

FIG. 161.—Amentum or catkin of Hazel (*Corylus Avellana*), consisting of an axis or rachis covered with bracts in the form of scales (*squamæ*), each of which covers a male flower, the stamens of which are seen projecting beyond the scale. The catkin falls off in a mass, separating from the branch by an articulation.

spikelets, which are either set closely along a central axis, or produced on secondary axes formed by the branching of the central one; to the latter form the term *panicle* is applied.

If the primary axis, in place of being elongated, is contracted, it gives rise to other forms of indefinite inflorescence. When the axis is so shortened that the secondary axes arise from a common point, and spread out as *radii* of nearly equal length, each ending in a single flower, or dividing again in a similar radiating manner, an *umbel* is produced, as in fig. 162. From the primary floral

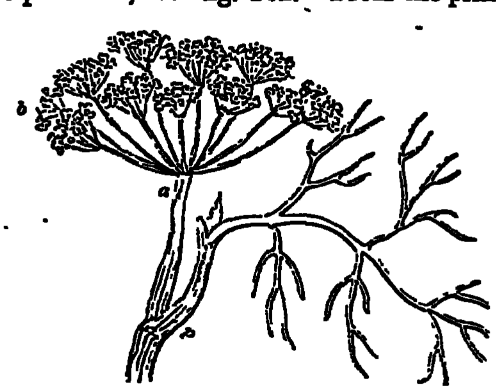


Fig. 162.

Compound umbel of Common Dill (*Anethum graveolens*), having a primary umbel *a*, and secondary umbels *b*, without either involucre or involucel. The petiole *p* of the leaf is sheathing, and has been denominated pericladium.

axis *a* the secondary axes come off in a radiating or umbrella-like manner, and end in small umbels *b*, which are called *partial umbels* or *umbellules*, to distinguish them from the *general umbel* formed by the branching of the primary axis. This inflorescence is seen in Hemlock, and other allied plants, which are hence called Umbelliferous. If there are numerous flowers on a flattened, convex, or slightly concave receptacle, having either very short pedicels or none, a *capitulum* (head), *anthodium*, or *calathium*, is formed, as in Dandelion, Daisy, and other Composite plants (fig. 146), also in Scabiosa (fig. 157) and Dipsacus. In the American Button-bush the heads are globular, in some species of Teazel, elliptical, while in Scabious, and in Composite plants, as Sunflower, Dandelion, Thistle, Centaury, and Marigold, they are somewhat hemispherical, with a flattened, slightly hollowed, or convex disk. If the margins of such a receptacle be developed upwards, the centre not developing, a concave receptacle is formed, which may partially or completely enclose a number of flowers that are generally unisexual. This gives rise to the peculiar inflorescence of Dorstenia (fig. 163), or to that of the Fig (fig. 150), where the flowers are placed on the inner surface of the hollow receptacle, and are provided with bracteoles. This inflorescence has been called *hypanthodium*.

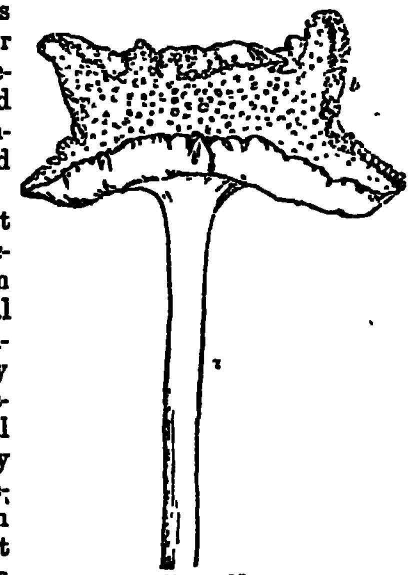


Fig. 163.

Peduncle *a* of *Dorstenia*, with concave receptacle *b*.

Lastly, we have what are called *compound indefinite* inflorescences. In these forms the lateral shoots, developed centripetally upon the primary axis, bear numerous bracteoles, from which floral shoots arise which may have a centripetal arrangement similar to that on the mother shoot, or it may be different. Thus we may have a group of racemes, arranged in a racemose manner on a common axis, forming a raceme of racemes or compound raceme, as in Astilbe. In the same way we may have compound umbels, as in Hemlock and most Umbelliferæ (fig. 162), a compound spike, as in Rye-grass, a compound spadix, as in some Palms, and a compound capitulum, as in the Hen-and-Chickens Daisy. Again, there may be a raceme of capitula, that is, a group of capitula disposed in a racemose manner, as in Petasites, a raceme of umbels, as in Ivy, and so on, all the forms of inflorescence being indefinite in disposition.

The elongation of secondary flower-stalks sometimes alters the general character of the inflorescence, changing a spike into a raceme, a raceme into a corymb, a capitulum into an umbel, and so forth. The capitulum of flowers in some Compositæ, such as Hypochæris radicata and Senecio vulgaris, by a similar change in the pedicels assumes the form of an umbel. Among Umbelliferæ the umbels are sometimes supported on very long stalks, while the pedicels of the individual flowers are not lengthened. In Eryngium the shortening of the pedicels changes an umbel into a capitulum. The umbellate inflorescence of Pelargonium has been seen changed into a raceme.

The simplest form of the definite type of inflorescence is seen in Anemone nemorosa and in Gentianella (Gentiana acaulis, fig. 164), where the axis terminates in a single flower, no other flowers being produced upon the plant. This is *solitary terminal* inflorescence. If other flowers were produced, they would arise as lateral shoots from the bracts below the first-formed flower. The general name of *cyme* is applied to the arrangement of a group of flowers in a definite inflorescence. A *cymose* inflorescence is an inflorescence where the primary floral axis before terminating in a flower gives off one or more lateral unifloral axes which repeat the process,—the development being only limited by the vigour of the plant. The floral axes are thus centrifugally developed. The cyme, according to its development, has been characterized as *biparous* or *uniparous*. In fig. 165 the biparous cyme is represented in the flowering branch of Erythræa Centaurium. Here the primary axis *a'* ends in a flower *f*, which has passed

Definite inflorescence

into the state of fruit. At its base two leaves are produced, each of which is capable of developing buds. These are flower-buds, and constitute secondary axes a'' a'', ending in single flowers f'' f'', which are thus terminal and solitary; and at the base of these axes a pair of opposite leaves is

Fig. 164.
Gentianella (*Gentiana acaulis*). *a*, axis; *b*, flower; *c*, bract.

Fig. 165.
Flowering branch of *Erythræa Centaurium*.

produced, giving rise to tertiary axes a''' a''' a''', ending in single flowers f''' f''' f''', and so on. The term *dichotomous* has also been applied to this form of cyme. But these terms are not strictly correct, for here there is no dichotomous branching, although, when the terminal flower f of the generating axis has withered, an apparent dichotomy occurs; but the lateral axes on the several shoots are produced monopodially, and therefore the term is apt to lead to confusion regarding the development of the shoots. The name *dichasium* has, therefore, been substituted for the old term. In the natural order Caryophyllaceæ (Pink family) the dichasial cymose form of inflorescence is very general. In some members of the tribe, as Dianthus barbatus, D. Carthusianorum, &c., in which the peduncles are short, and the flowers closely approximated, with a centrifugal expansion, the inflorescence has the form of a contracted dichasium, and receives the name of *fascicle* (fig. 166). A

Fig. 166.
Fascicle of Mallow (*Malva sylvestris*).

similar inflorescence is seen in Xylophylla longifolia. When the axes become very much shortened, the arrangement is more complicated in appearance, and the nature of the inflorescence can only be recognized by the order of opening of the flowers. In Labiate plants, as the Dead-nettle (Lamium), the flowers are produced in the axil of each of the foliage leaves of the plant, and they appear as if arranged in a simple whorl of flowers. But on examination it is found that there is a central flower expanding first, and from its axis two secondary axes spring bearing solitary flowers; the expansion is thus centrifugal. The inflorescence is therefore a contracted dichasium, the flowers being sessile, or nearly so, and the clusters are called *verticillasters* (fig. 167).

Fig. 167.
Flowering stalk of the White Dead-nettle, (*Lamium album*). The bracts *b*, *b* are like the ordinary leaves of the plant, and produce clusters of flowers in their axil. The clusters are called verticillasters, and consist of flowers which are produced in a centrifugal manner.

Sometimes, especially towards the summit of a dichasium, owing to the exhaustion of the growing power of the plant, only one of the bracts gives origin to a new axis, the other remaining empty; thus the inflorescence becomes unilateral, and further development is arrested. In addition to the dichasial form there are others where more than two lateral axes are produced from the primary floral axis, each of which in turn produces numerous axes. To this form the terms *trichotomous* and *polytomous cyme* have been applied; but these are now usually designated *cymose umbels*. They are well seen in some species of Euphorbia. Another term, *anthela*, has been used to distinguish such forms as occur in several species of Luzula and Juncus, where numerous lateral axes arising from the primary axis grow very strongly, and develop in an irregular manner.

In the uniparous cyme a number of floral axes are successively developed one from the other, but the axis of each successive generation, instead of producing a pair of bracts, produces only a single one. The basal portion of the consecutive axes may become much thickened and arranged more or less in a straight line, and thus collectively form an apparent or false axis or *sympodium*, and the inflorescence thus simulates a raceme. In the true raceme, however, we find only a single axis, producing in succession a series of bracts, from which the floral peduncles arise as lateral shoots, and thus each flower is on the same side of the floral axis as the bract in the axil of which it is developed; but in the uniparous cyme the flower of each of these axes, the basal portions of which unite to form the false axis, is situated on the opposite side of the axis to the bract from which it apparently arises (fig. 168). This bract is not, however, the one from which the axis terminating in the flower arises, but is a bract produced upon it, and gives origin in its axil to a new axis, the basal portion of which, constituting the next part of the false axis, occupies the angle between this bract and its parent axis, —the bract from which the axis really does arise being situated lower down upon the same side of the axis with itself. The uniparous cyme presents two forms, the *scorpioid* or *cicinal* and the *helicoid* or *bostrychoid*.

In the scorpioid cyme the flowers are arranged alternately in a double row along one side of the false axis (fig. 169) the bracts when developed forming a second double

row on the opposite side, as seen in the Henbane; the whole inflorescence usually curves on itself like a scorpion's tail, hence its name. In fig. 170 is shown a diagrammatic sketch of this arrangement. The false axis, *a b c d*, is formed by

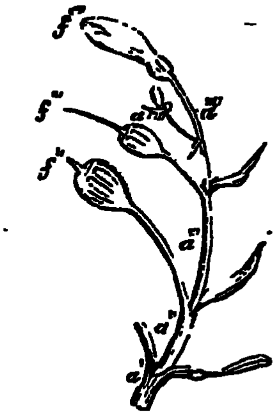


Fig. 168.

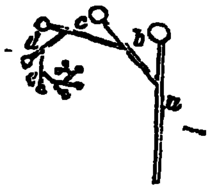


Fig. 170.

Fig. 169.

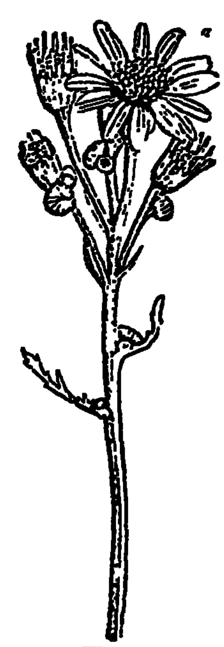


Fig. 171.

FIG. 168.—False raceme or helicoid cyme of a species of Alströmeria. $a' a'' a''' a''''$ are separate axes successively developed, which appear to form a simple continuous raceme, of which the axes form the internodes. It is a definite uniparous inflorescence, however, with centrifugal evolution. Each of the axes is produced in the axil of a leaf, and is terminated by a flower $f' f'' f''' f''''$, opposite to that leaf, and the axes have a spiral arrangement.
FIG. 169.—Scorpioidal or cicinal cyme of Forget-me-not (*Myosotis palustris*).
FIG. 170.—Diagram of definite floral axes *a, b, c, d, e*.
FIG. 171.—Flowering stalk of a kind of Ragwort (*Senecio*). The flowers are in heads (capitula), and open from the circumference inwards in an indefinite centripetal manner. The heads of flowers, on the other hand, taken collectively, expand centrifugally—the central one *a* first. Each head of flowers terminates a separate axis. They form together a corymb of capitula. The inflorescence is called mixed.

successive generations of unifloral axes, the flowers being arranged along one side alternately and in a double row; had the bracts been developed they would have formed a similar double row on the opposite side of the false axis; the whole inflorescence is represented as curved on itself. In fig. 169 the same scorpioid form of uniparous cyme is seen in the Forget-me-not, with the double row of flowers on one side of the false axis, but in this case the bracts, which should appear on the opposite side, are not developed, and hence the cyme is not complete. The inflorescences in the family Boraginaceæ are usually regarded as true scorpioid cymes. But it has been recently shown that in Myosotis (Forget-me-not) the axis is not a sympodium, but the branching takes place monopodially, therefore it should more correctly be regarded as a raceme with flowers only on one side and curving on itself. In Hyoscyamus (Henbane) and other Atropaceæ the branching is dichotomous, so that the inflorescence in this case also ought not to be regarded as a scorpioid cyme.

In the helicoid cyme there is also a false axis formed by the basal portion of the separate axes, but the flowers are not placed in a double row, but in a single row, and form a spiral or helix round the false axis. In Alströmeria, as represented in fig. 168 the axis a' ends in a flower (cut off in the figure) and bears a leaf. From the axil of this leaf, that is, between it and the primary axis a' arises a secondary axis a'', ending in a flower f'', and producing a leaf about the middle. From the axil of this leaf a tertiary floral axis a''', ending in a flower f''', takes origin. In this case the axes are not arranged in two rows along one side of the false axis, but are placed at regular intervals, so as to form an elongated spiral round it.

Compound definite inflorescences are by no means common, but in Streptocarpus polyanthus, and in several Calceolarias, we probably have examples. Here there are *scorpioid cymes of pairs of flowers*, each pair consisting of an older and a younger flower.

Forms of inflorescence occur, in which both the definite and indefinite types are represented; these, then, are *mixed* inflorescences. Thus in Composite plants, such as Hawk-weeds (Hieracia) and Ragworts (Senecio, fig. 171), the *heads* of flowers, taken as a whole, are developed centrifugally, the terminal head first, while the *florets*, or small flowers on the receptacle, open centripetally, those at the circumference first. So also in Labiatæ, such as Dead-nettle (Lamium), the different whorls of inflorescence are developed centripetally, while the florets of the verticillaster are centrifugal. This mixed character presents difficulties in such cases as Labiatæ, where the leaves, in place of retaining their ordinary form, become bracts, and thus might lead to the supposition of the whole series of flowers being one inflorescence. In such cases the cymes are described as spiked, racemose, or panicled, according to circumstances. In Saxifraga umbrosa (London-pride) and in the Horse-chestnut we meet with a raceme of scorpioid cymes; in Sea-pink, a capitulum of contracted scorpioid cymes (often called a glomerulus); in Laurustinus, a compound umbel of dichasial cymes; a scorpioid cyme of capitula in Vernonia centriflora. In the catkins of the Birch we have, in reality, spikes of contracted dichasial cymes. In the Bell-flower (Campanula), there is a racemose uniparous cyme. In the Privet (Ligustrum vulgare) there are numerous racemes of dichasia arranged in a racemose manner along an axis; the whole inflorescence thus has an appearance not unlike a bunch of grapes, and has been called a *thyrsus*.

Mixed inflorescence

TABULAR VIEW OF INFLORESCENCE.

A. Indefinite Centripetal Inflorescence.
- I. Flowers solitary, axillary. *Vinca, Veronica hederifolia.*
- II. Flowers in groups, pedicellate.
  - 1. Elongated form (Raceme), *Hyacinth, Laburnum, Currant.* (Corymb), *Ornithogalum.*
  - 2. Contracted or shortened form (Umbel), *Cowslip, Astrantia*
- III. Flowers in groups, sessile.
  - 1. Elongated form (Spike), *Plantago.* (Spikelet), *Grasses.* (Amentum, Catkin), *Willow, Hazel.* (Spadix) *Arum*, some *Palms.* (Cone), *Fir, Spruce.* (Strobilus), *Hop.*
  - 2. Contracted or shortened form (Capitulum), *Daisy, Dandelion, Scabious.*
- IV. Compound Indefinite Inflorescence.
  - *a.* Compound Spike, *Rye-grass.*
  - *b.* Compound Spadix, *Palms.*
  - *c.* Compound Raceme, *Astilbe.*
  - *d.* Compound Umbel, *Hemlock* and most *Umbelliferæ.*
  - *e.* Raceme of Capitula, *Petasites.*
  - *f.* Raceme of Umbels, *Ivy.*

B. Definite Centrifugal Inflorescence.
- I. Flowers solitary, terminal. *Gentianella, Peony.*
- II. Flowers in Cymes.
  - 1. Uniparous Cyme.
    - *a.* Helicoid Cyme (axes forming a spiral).
      - * Elongated form. *Alströmeria.*
      - ** Contracted form, [illegible]
    - *b.* Scorpioid Cyme (axes unilateral, two rows).
      - * Elongated form, *Forget-me-not, Symphytum, Henbane.*
      - ** Contracted form, *Erodium, Alchemilla arvensis.*

2. Biparous Cyme (Dichotomous), including 3-5-chotomous Cymes (Dichasium, Cymose Umbel, Anthela).
   a. Elongated form, *Cerastium*, *Stellaria*.
   b. Contracted form (Verticillaster), *Dead-nettle*, *Pelargonium*.
3. Compound Definite Inflorescence. *Streptocarpus polyanthus*, many *Calceolarias*.

C. Mixed Inflorescence.
1. Raceme of Scorpioid Cymes, *Horse-chestnut*.
2. Scorpioid Cyme of Capitula, *Vernonia centriflora*.
3. Compound Umbel of Dichotomous Cymes, *Laurustinus*.
4. Capitulum of contracted Scorpioid Cymes (Glomerulus), *Sea-pink*.

The flower. The flower is the *tout ensemble* of those organs which are concerned in reproduction. It is constituted by a portion of the floral axis bearing the sexual organs, usually with certain protective envelopes. The parts borne on the floral axis and composing the flower are all metamorphosed leaves, and, though usually very different in appearance from foliage leaves, their morphological resemblance is frequently shown by their developing as foliage leaves. The axis bearing the parts of the flower is usually very much contracted, no internodes being developed, and it frequently expands into a flattened or hollowed expansion termed the *thalamus* or *torus*; at other times, though rarely, the internodes are developed and it is elongated. Upon this torus the parts of the flower are arranged in a crowded manner, usually forming a series of verticils, the parts of which alternate; but they are sometimes arranged in a spiral manner, especially if the floral axis be elongated. In a typical flower, as in fig. 172, we recognize four distinct whorls of leaves:—an outer whorl of five parts, the *calyx*; within it, another whorl of five parts alternating with those of the outer whorl, the *corolla*; next comes a whorl of parts alternating with the parts of the corolla, the *andrœcium*; and in the centre is the *gynœcium*. Fig 173 is a diagrammatic representation of the arrangement of the parts of such a flower. The flower is supposed to be cut transversely, and the parts of each whorl are distinguished by a different symbol. Of these whorls the two internal, forming the male and female sexual organs, constitute the *essential* organs of reproduction; the two outer whorls are the protective coverings or *floral envelopes*. The calyx or outer covering (fig. 172, *c*) is formed of leaves, called *sepals*, which are generally of a greenish colour. The corolla *p*, the next covering, is composed of leaves, called *petals*, which are often showy, and normally alternate with the sepals. Sometimes, as in many Monocotyledons, the calyx and corolla *both* display rich colouring, and are apt to be confounded. In such cases the term *perianth*, or *perigone*, has been applied to avoid ambiguity. Thus, in the Tulip, Crocus, Lily, Hyacinth, authors speak of the parts of the perianth, in place of calyx and corolla, although in these plants an outer whorl (calyx) may be detected, of three parts, and an inner (corolla), of a similar number, alternating with them. When the parts of the calyx are in appearance like petals they are said to be *petaloid*, as in Liliaceæ. In some cases the petals have the appearance of sepals, then they are *sepaloid*, as in Juncaceæ. The term perianth is usually confined to the flowers of Monocotyledons, whatever colour they present, whether green, as in Asparagus, or coloured, as in Tulip. Some use the term perianth as a general one, and restrict the use of perigone to cases where a pistil only is present. In plants, as Nymphæa alba, where a spiral arrangement of the floral leaves occur, it is not easy to say where the calyx ends and the corolla begins, as these two whorls pass insensibly into each other. When both calyx and corolla are present, the plants are *dichlamydeous*; occasionally one becomes abortive, and then the flower is *monochlamydeous* (fig. 174), having a calyx only, or *apetalous*, having no petals. At times both are abortive, and then the flower is *achlamydeous*, or naked. It is important to remember that if only one perianth-whorl is present it is the calyx. The outermost whorl of the essential organs, collectively termed the *andrœcium*, is composed of a series of leaves

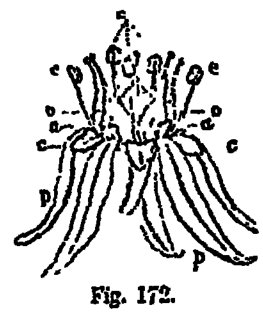


Fig. 172.

Fig. 175.

Fig. 173.

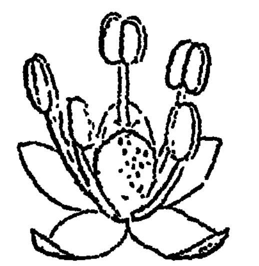


Fig. 174.

Fig. 176.

FIG. 172.—Flower of *Crassula rubens*. *c, c*, sepals; *p, p*, petals; *e, e*, stamens; *a, a*, carpels, each of them having a small scale-like appendage *a* at the base.

FIG. 173.—Diagram of a completely symmetrical flower, consisting of four whorls, each consisting of five parts. The outer row is the calyx formed of five sepals; the second is the corolla of five petals, alternating with the sepals; the third is the andrœcium, consisting of five stamens, alternating with the petals; the central whorl is the gynœcium, consisting of five carpels, alternating with the stamens.

FIG. 174.—Monochlamydeous (apetalous) flower of Goosefoot (*Chenopodium*), consisting of a single perianth (calyx) of five parts, enclosing five stamens, which are opposite the divisions of the perianth, owing to the absence of the petals.

FIG. 175.—Stamen, consisting of a filament (stalk) *f* and an anther *a*, containing powdery matter *p*, denominated pollen, which is discharged through slits in the two lobes of the anther.

FIG. 176.—The pistil of Tobacco (*Nicotiana Tabacum*), consisting of the ovary *o*, containing ovules, the style *s*, and the capitate stigma *g*. The pistil is placed on the receptacle *r*, at the extremity of the peduncle.

distinguished as the staminal leaves or *stamens*. These are the male sexual organs. In their most differentiated form each consists of a stalk, either filiform or foliaceous, the *filament* (fig. 175, *f*) supporting at its summit a lobed saccate mass, the *anther* (fig. 175, *a*), which contains a powdery matter, the *pollen* (fig. 175, *p*), which is discharged therefrom. In many cases, however, the staminal leaf resembles more nearly a cataphyllary leaf, bearing the pollen-sacs scattered over its surface, as in Cycadaceæ. The *gynœcium* or *pistil* is the central portion of the flower, and is the female sexual organ. It consists of one or more folded leaves, called *carpels*, either separate (fig. 172, *c*) or combined (fig. 174.) The parts distinguished in the pistil are the *ovary* (fig. 176, *o*), which is the lower portion enclosing the *ovules* destined to become seeds, and the *stigma* (fig. 176, *g*), a portion of loose cellular tissue uncovered by epidermis, which is either sessile on the apex of the ovary, as in the Poppy, or is separated from it by a prolonged portion called the *style* (fig. 176, *s*). The andrœcium and gynœcium are not present in all flowers. When both are present the flower is *hermaphrodite*; and in descriptive botany such a flower is indicated by the symbol ☿. When Plate XV. Plate I.

only one of those organs is present the flower is *unisexual* or *diclinous*, and is either male (*staminate*), ♂, or female (*pistillate*), ♀. A flower then normally consists of the four whorls of leaves,—calyx, corolla, andrœcium, and gynœcium,—and when these are all present the flower is *complete*. These several whorls of the flower are usually densely crowded upon the thalamus, but in some instances, after apical growth has ceased in the axis, an elongation of portions of the receptacle by intercalary growth occurs, by which changes in the position of the parts may be brought about. Thus in Lychnis an elongation of the axis betwixt the calyx and the corolla takes place, and in this way they are separated by an interval. Again, in Passiflora the stamens are separated from the corolla by an elongated portion of the axis, which has consequently been termed the *androphore;* and in Passiflora, Fraxinella (fig. 177), Capparidaceæ, and some other plants, the ovary is raised upon a distinct stalk termed the *gynophore;* it is thus separated from the stamens, and is said to be *stipitate*. The apical growth of the floral axis in the flower soon ceases, and therefore the parts are arranged in whorls; but at times, as in the Ranunculaceæ, Magnoliaceæ, &c., the growth is of sufficient duration to permit a spiral arrangement of parts. Usually the successive whorls of the flower disposed from below upwards or from without inwards upon the floral axis are of the same number of parts, or are a multiple of the same number of parts, those of one whorl alternating with those of the whorls next it.

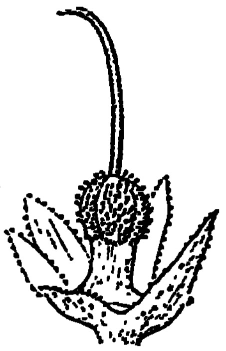


Fig. 177.

Calyx and pistil of Fraxinella (*Dictamnus Fraxinella*). The pistil consists of several carpels, which are elevated on a stalk prolonged from the receptacle. The stalk is called gynophore or thecaphore.

nmetry he er.

When a flower consists of parts arranged in whorls it is said to be *cyclic*, and if all the whorls have an equal number of parts and are alternate it is *eucyclic*. In contrast to the cyclic flowers are those, as in Magnoliaceæ, where the parts are in spirals. When in such a flower the transition from one foliar structure to another, *i.e.*, from calyx to corolla, from corolla to stamens, &c., does not coincide with a definite number of turns of the spiral it is said to be *acyclic;* if it does so correspond it is termed *hemicyclic;* the latter term also includes flowers which are cyclic at one portion and spiral at another, as in many Ranunculaceæ. In spiral flowers the distinction into whorls is by no means easy, and usually there is a gradual passage from sepaloid through petaloid to staminal parts, as in Nymphæaceæ (figs. 178, 179), although in some plants

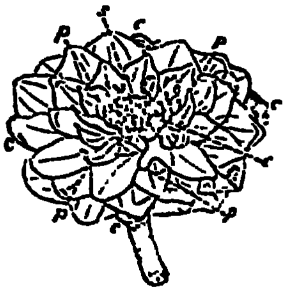


Fig. 178.

Fig. 179.

FIG. 178.—Flower of *Nymphæa alba*, White Water-lily. c, c, c, c, the four foliols of the calyx or sepals; p, p, p, p, petals; e, stamens; s, pistil.

FIG. 179.—Parts of the flower separated to show the transition from the green sepals of the calyx c, and the white petals of the corolla p, to the stamens e. The latter present changes from their perfect state, 5, through intermediate forms, 4, 3, 2, and 1, which gradually resemble the petals.

there is no such distinction, the parts being all petaloid, as in Trollius. We may again note here that some regard the cone in Coniferæ and Cycadaceæ as a single flower, and in that case the whorls are much separated and arranged spirally along the floral axis. Normally, the parts of successive whorls alternate; but in some cases we find the parts of one whorl opposite or *superposed* to those of the next whorl. In some cases, as in the Ampelideæ, this seems to be the ordinary mode of development, but in Caryophyllaceæ the superposition of the stamens on the sepals in many plants seems to be due to the suppression or abortion of the whorl of petals, and this idea is borne out by the development, in some plants of the order, of the suppressed whorl. In Primulaceæ, again, where there is a superposition of stamens and petals the abnormality is due apparently to another cause. The petals are developed after the stamens, and are to be regarded as appendages from them, of the same nature as the appendages to the stamens in Asclepiadaceæ, so that morphologically in Primulaceæ, according to this view, there are no petals. As a rule, whenever we find the parts of one whorl superposed to those of another we may suspect some abnormality. Frequently, when parts are superposed they become adherent to one another; thus the stamens become adherent to the petals or are *epipetalous*, or to the sepals and are *episepalous*.

A flower is said to be *symmetrical* when each of its whorls consists of an equal number of parts, or when the parts of any one whorl are multiples of that preceding it. Thus, a symmetrical flower may have five sepals, five petals, five stamens, and five carpels, or the number of any of these parts may be ten, twenty, or some multiple of five. Fig. 173 is a diagram of a symmetrical flower, with five parts in each whorl, alternating with each other. In fig. 180 there is a section of a symmetrical flower of Stone-crop, with five sepals, five alternating petals, ten stamens, and five carpels. Here the number of parts in the staminal whorl is double that in the others, and in such a case the additional five parts form a second row alternating with the others. In the staminal whorl especially it is common to find additional rows. In fig. 181 there is a

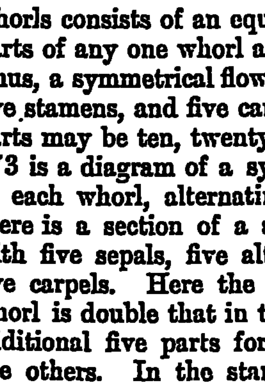


Fig. 180.

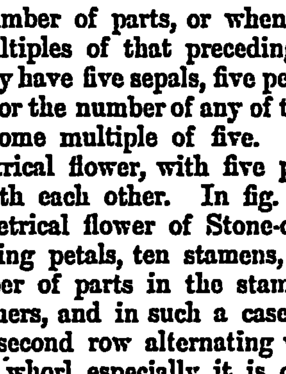


Fig. 181.

FIG. 180.—Diagrammatic section of a symmetrical pentamerous flower of Stone-crop (*Sedum*), consisting of five sepals externally, five petals alternating with the sepals, ten stamens in two rows, and five carpels containing seeds. The dark lines on the outside of the carpels are glands.

FIG. 181.—Diagram of the flower of Flax (*Linum*), consisting of five sepals, five petals, five stamens, and five carpels, each of which is partially divided into two. It is pentamerous, complete, symmetrical, and regular.

symmetrical flower, with five parts in the three outer rows, and ten divisions in the inner. In this case it is the gynœcium which has an additional number of parts. Fig. 182 shows a flower of Heath, with four divisions of the calyx and corolla, eight stamens in two rows, and four divisions of the pistil. In fig. 183 there are three parts in each whorl; and in figs. 184 there are three divisions of the calyx, corolla, and pistil, and six stamens in two rows. In all these cases the flower is symmetrical. Where, as in the Stone-crop, an extra row of parts is developed in any whorl they may be either formed in regular succession within the first row, or they may be interposed to them, *i.e.*, formed between them, or even external to and beneath them. We have examples of the former in many Caryophyllaceous plants, the latter being well seen in Crassulaceæ, Geraniaceæ, &c. In Monocotyledons it is

usual for the staminal whorl to be double, it rarely having more than two rows, whilst amongst Dicotyledons there are often very numerous rows of stamens. The floral envelopes are rarely multiplied Flowers in which the number of parts

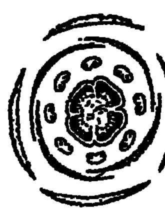


Fig. 182

Fig. 183.

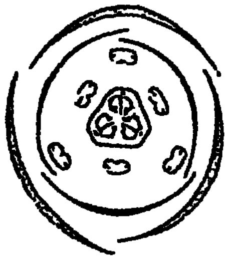


Fig. 184.

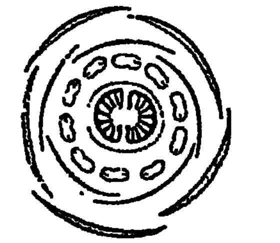


Fig. 185.

FIG. 182—Diagram of the flower of Heath (*Erica*), having four sepals, four divisions of the corolla, eight stamens in two rows, and four divisions of the pistil. The flower is tetramerous, complete, symmetrical, and regular.

FIG. 183.—Diagram of the trimerous symmetrical flower of Iris. There are three alternating divisions of each whorl. Below is a single bract.

FIG. 184.—Diagram of the symmetrical trimerous flower of Fritillary, having three divisions of the two outer whorls, and of the pistil in the centre, and six stamens in two rows.

FIG. 185.—Diagram of the flower of Saxifrage (*Saxifraga tridactylites*). The calyx and corolla consist of five parts, the stamens are ten in two rows, while the pistil has only two parts developed. The flower is, nevertheless, called symmetrical, although the outer whorls are pentamerous, and the central one dimerous

in each whorl is the same, are *isomerous* (of equal number); when the number in some of the whorls is different, the flower is *anisomerous* (of unequal number). The pistilline whorl is very liable to changes. It frequently happens that when it is fully formed, the number of its parts is not in conformity with that of the other whorls. In such circumstances, however, a flower has been called symmetrical, provided the parts of the other whorls are normal, —the permanent state of the pistil not being taken into account in determining symmetry. Thus, fig. 185 shows a pentamerous symmetrical flower, with dimerous pistils. Symmetry, then, in botanical language, has reference to a certain definite numerical relation of parts. A flower in which the parts are arranged in twos, is called *dimerous*, the symmetry being *binary* and the arrangement marked thus ²/. This may be considered either as analogous to opposite decussating leaves, or as composed of distichous alternate leaves belonging to the one-half series. When the parts of the floral whorls are three, the flower is *trimerous*, and the symmetry being *ternary* or trigonal is marked ³/. This may be looked upon as composed of verticillate leaves, or of tristichous alternate leaves with the angular divergence $\frac{1}{3}$. When floral whorls have parts in a series of four, the flower is *tetramerous*, its symmetry being *quaternary*, and marked ⁴/. A *pentamerous* flower, marked ⁵/, has *quinary* or *pentagonal* symmetry. The symmetry which is most commonly met with in the vegetable kingdom is trimerous and pentamerous—the former occurring generally among Monocotyledons, the latter among Dicotyledons. Dimerous or tetramerous symmetry occurs also among Dicotyledonous plants, and the numbers 2 and 4 prevail in the reproductive organs of Acotyledons. The various parts of the flower have a certain definite relation to the axis. Thus, in axillary tetramerous flowers (fig. 182), one sepal is next the axis, and is called *superior* or *posterior*: another is next the bract, and is *inferior* or *anterior*, and the other two are *lateral*; and certain terms are used to indicate that position. A plane passing through the anterior and posterior sepal and through the floral axis is termed the *median plane* of the flower; a plane cutting it at right angles, and passing through the lateral sepals, is the *lateral plane*; whilst the planes which bisect the angles formed by the lateral and median planes are the *diagonal planes*, and in these flowers the petals which alternate with the sepals are cut by the diagonal planes.

In a pentamerous flower one sepal may be superior, as in the calyx of Rosaceæ and Labiatæ; or it may be inferior, as in the calyx of Leguminosæ (fig. 186),—the reverse, by the law of alternation, being the case with the petals. Thus, in the blossom of the Pea (fig. 187), the odd petal (vexil-

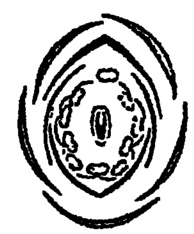


Fig. 186.

Fig. 187.

FIG. 186.—Diagram of flower of Sweet-pea (*Lathyrus*), showing five parts of the calyx, of which two are superior, one inferior, and two lateral; five parts of the corolla, of which one is superior, two inferior, and two lateral; ten stamens in two rows; one carpel, in consequence of four being undeveloped.

FIG. 187.—Flower of Pea (*Pisum sativum*), showing a papilionaceous corolla, with one petal superior, *st*, called the standard (vexillum), two inferior, *car*, called the keel (carina), and two lateral, *a*, called wings (alæ). The calyx is marked *c*.

lum) *st* is superior, while the odd sepal is inferior. In the Figwort order one of the two carpels is posterior and the other anterior, whilst in Convolvulaceæ the carpels are arranged laterally. Sometimes the twisting of a part makes a change in the position of other parts, as in Orchids, where the twisting of the ovary changes the position of the labellum. When the different members of each whorl are like in size and shape, the flower is said to be *regular*; while differences in the size and shape of the parts of a whorl make the flower *irregular*, as in the Papilionaceous flower, represented in fig. 187. When a flower can be divided by a single median plane into two exactly similar parts, then it is said to be *zygomorphic*. Such flowers as Papilionaceæ, Labiatæ, are examples. In contrast with this are *polysymmetrical* flowers, which can be divided by several planes into several exactly similar portions; such are all regular, symmetrical flowers. When the parts of any whorl are not equal to or some multiple of the others, then the flower is *unsymmetrical*. This want of symmetry may be brought about in various ways. A consideration of the various unsymmetrical, irregular, and incomplete forms of the flower, and the processes by which they have been brought about, constitutes *Teratology*. Alteration in the symmetrical arrangement as well as in the completeness and regularity of flowers has been traced to *suppression* or the *non-development* of parts, *degeneration* or imperfect formation, *cohesion* or union of parts of the same whorl, *adhesion* or union of the parts of different whorls, *multiplication* of parts, and *deduplication* (sometimes called *chorisis*) or splitting of parts.

By *suppression* or non-appearance of a part at the place where it ought to appear if the structure was normal, the symmetry or completeness of the flower is disturbed. This suppression when confined to the parts of certain verticils makes the flower unsymmetrical. Thus, in the flowers of Staphylea there are five parts of the calyx, five petals, five stamens, and only two carpels; in many Caryophyllaceæ, as Polycarpon and Holosteum, while the calyx and corolla are pentamerous, there are only three or four stamens and three carpels; in Impatiens noli-me-tangere the calyx is

composed of three parts, while the other verticils have five; in Labiate flowers there are five parts of the calyx and corolla, and only four stamens; and in Tropæolum pentaphyllum there are five sepals, two petals, eight stamens, and three carpels. In all these cases the want of symmetry is traced to the suppression of certain parts. In the last-mentioned plant the normal number is five, hence it is said that there are three petals suppressed, as shown by the position of the two remaining ones; there are two rows of stamens, in each of which one is wanting, and there are two carpels suppressed. In many instances the parts which are afterwards suppressed can be seen in the early stages of growth, and occasionally some vestiges of them remain in the fully developed flower. By the suppression of the verticil of the stamens, or of the carpels, flowers become *unisexual*, or *diclinous*, and by the suppression of one or both of the floral envelopes, monochlamydeous and achlamydeous flowers are produced. The suppression of parts of the flower may be carried so far that at last a flower consists of only one part of one whorl. In the Euphorbiaceæ we have an excellent example of the gradual suppression of parts, where from an apetalous trimerous staminal flower we pass to one where one of the stamens is suppressed, and then to forms where two of them are wanting. We next have flowers in which the calyx is suppressed, and its place occupied by one, two, or three bracts (so that the flower is, properly speaking, achlamydeous), and only one or two stamens are produced. And finally, we find sterile flowers consisting of a single stamen with a bract, and fertile flowers consisting of a single carpel with a bract. There is thus traced a *degradation*, as it is called, from a flower with three stamens and three divisions of the calyx, to one with a single bract and a single stamen or carpel.

Degeneration, or the transformation of parts, often gives rise either to an apparent want of symmetry or to irregularity in form. In unisexual flowers it is not uncommon to find vestiges of the undeveloped stamens in the form of filiform bodies or scales. To many of these staminal degenerations Linnæus gave the name of *nectaries*. In double flowers transformations of the stamens and pistils take place, so that they appear as petals. In Canna, what are called petals are in reality metamorphosed stamens. In the capitula of Compositæ we sometimes find the florets converted into green leaves. The limb of the calyx may appear as a rim, as in some Umbelliferæ; or as pappus, in Compositæ and Valeriana. In Scrophularia the fifth stamen appears as a scale-like body, called *staminodium*; in other Scrophulariaceæ, as in Pentstemon, it assumes the form of a filament, with hairs at its apex in place of an anther.

Cohesion, or the union of parts of the same whorl, and *adhesion*, or the growing together of parts of different whorls, are very common causes of change both as regards form and symmetry. Thus in Cucurbita the stamens are originally five in number, but subsequently some cohere, so that three stamens only are seen in the mature flower. Again, amongst Malvaceæ the stamens cohere by their margins. Cases of what are called gamopetalous corollas, gamosepalous calyces, &c., must be distinguished carefully from such a process as this; for in these cases the parts were never free from one another, but developed from the very first as one mass; and the same caution is necessary in many instances of so-called union of stamens, which are really cases of branching. Adhesion is well seen in the *gynostemium* of Orchids, where the stamens and ovary adhere; and in flowers where the stamens are *perigynous*, *i.e.*, are adherent to the calyx. In Capparidaceæ the calyx and petals occupy their usual position, but the axis is prolonged in the form of a gynophore, to which the stamens are united. Cohesion and adhesion are rare amongst Monocotyledons.

Multiplication, or an increase of the number of parts, gives rise to changes in plants. We have already alluded to the interposition of new members in a whorl. This takes place chiefly in the staminal whorl, but usually the additional parts produced form a symmetrical whorl with the others. In some instances, however, this is not the case. Thus in the Horse-chestnut there is an interposition of two stamens betwixt the other whorl, and thus seven stamens are formed in the flower, which is unsymmetrical.

Parts of the flower are often increased by a process of *deduplication*, *unlining*, *dilamination*, or *chorization*, *i.e.*, the splitting of a part so that two or more parts are formed out of what was originally one. This is believed by some to take place in a remarkable degree in the case of appendages to petals. Thus, in Ranunculus, the petal has a scale at its base, which is looked upon as a mere fold of it. This fold may in some cases be more highly developed, as in Caryophyllaceæ, and in Crassula rubens (fig. 172, *a*). Others refer such cases to the formation of outgrowths similar in nature to the ligule in Grasses. In Cruciferous plants a case of chorisis is said to occur. There the staminal whorl consists of four long stamens and two short ones (*tetradynamous*). The symmetry in the flower is evidently dimerous, and the abnormality in the andrœcium, where the four long stamens are opposite the posterior sepals, is said to take place by a splitting of the filaments of two stamens into four; and thus the two long stamens on each side are, by *gemination*, normally one. This view is supported by cases in which the filaments of the long stamens are more or less united; also by cases in which the shorter filaments exhibit tooth-like processes on both sides, while the longer ones have them only on the outer side. In such cases the two long filaments, if united, would present the same appearance as the shorter ones, and occupy their usual position of alternation with the petals. In some instances, by *pelorization*, it is found that tetradynamous plants become tetrandrous, with stamens of equal length alternating with the petals. Many cases of what was considered chorisis are in reality due to the development of stipules from the staminal leaf. Thus in Dicentra and Corydalis there are six stamens in two bundles; the central one of each bundle alone is perfect, the lateral ones have each only half an anther, and they are really stipules formed from the staminal leaf. Branching of stamens also produces apparent want of symmetry; thus, in the so-called polyadelphous stamens of Hypericaceæ there are really only five stamens which give off numerous branches, but the basal portion remaining short, the branches have the appearance of separate stamens, and the flower thus seems unsymmetrical.

Cultivation has a great effect in causing changes in the various parts of plants. Many alterations in form, size, number, and adhesion of parts are due to the art of the horticulturist. The changes in the colour and forms of flowers thus produced are endless. In the Dahlia the florets are rendered quilled, and are made to assume many glowing colours. In Pelargonium the flowers have been rendered larger and more showy; and such is also the case with the Ranunculus, the Auricula, and the Carnation. Some flowers, with spurred petals in their usual state, as Columbine, are changed so that the spurs disappear; and others, as Linaria, in which one petal only is usually spurred, are altered so as to have all the petals spurred, and to present what are called *pelorian* varieties.

As a convenient method of expressing the arrangement of the parts of the flower, floral formulæ have been devised. Several modes of expression are employed. The following is a very simple mode which has been proposed:—The several whorls are represented by the letters S sepals, P petals, St stamens, C carpels, and a figure marked after each indicates the number of parts in that whorl. Thus the formula $S_5P_5St_5C_5$ means that the flower is perfect, and has Floral formulæ

pentamerous symmetry, the whorls being isomerous. Such a flower as that of Sedum (fig. 180) would be represented by the formula $S_5P_5St_{5+5}C_5$, where St_{5+5} indicates that the staminal whorl consists of two rows of five parts each. A flower such as the male flower of the Nettle (fig. 188) would be expressed $S_4P_0St_4C_0$. It is also possible to indicate, in cases where members of a whorl are absent, which of them are wanting; thus, in the flower of an Orchis we have $S_3P_3St_{1+0}C_3$. Here St_{1+0} indicates that the anterior stamen of the outer row is present, the other two stamens of the row, marked as dots, are wanting, as also all the stamens of the inner row. In Cypripedium, on the other hand, the formula is $S_3P_3St_{0+2}C_3$, for here all the stamens of the outer row and the anterior one of the inner row are absent. When no other mark is appended the whorls are supposed to be alternate; but if it is desired to mark the position of the whorls special symbols are employed. Thus, to express the superposition of one whorl upon another, a line is drawn between them, *e.g.*, the symbol $S_5P_5 \mid St_5C_5$ is the formula of the flower of Primulaceæ. To indicate the interposition of a row of parts in a whorl a dot is placed between the coefficients, thus $S_5P_5St_{5\cdot5}C_5$ indicates that an extra row of five stamens has been interposed between those already in existence. To represent adhesions and cohesions leads to complicated formulæ, but in many cases cohesion can be easily indicated. Thus in the formula $\hat{S}_4\hat{P}_4St_2\hat{C}_2$, we have the arrangement of the parts of the flower in Veronica indicated, the sepals and the petals being united and the two carpels also being united into one pistil. The papilionaceous flower, of which fig. 186 is a diagram, may be formulated $\hat{S}_5P_5St_{5+(\overset{\frown}{4}+1)}C_1$. *We thus* learn that there are five sepals united, five free petals, ten stamens in two rows, of which nine are united and one is free, and there is one carpel. When the parts of the flower are arranged spirally on the floral axis, as in Magnoliaceæ and other flowers, the formula is prefixed by a curved line thus ⊂⊃, and then the angle of divergence of the members may be marked in addition to their number. Many other points in the arrangement of the flower may be attached to the formula by different symbols, according to the object which one has in view.

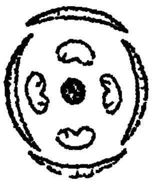
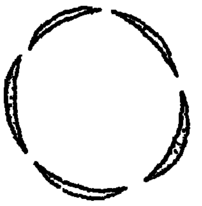
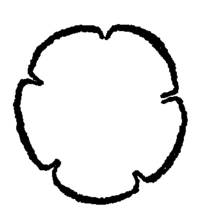
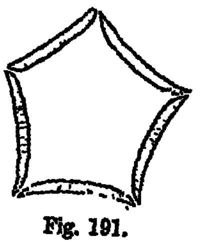




Fig. 188. Fig. 189. Fig. 190.

FIG. 188.—Tetramerous male (unisexual) flower of the Nettle (*Urtica*). It is incomplete, as it wants petals and pistil; and it *is said to* be monochlamydeous. One sepal is next *the* axis, and is called *posterior or superior*, another is next the bract, called anterior or inferior, and two are lateral, that is, to the right and left of the axis.
FIG. 189.—Diagram to illustrate valvular or valvate æstivation, in which the parts are placed in a circle, without overlapping or folding.
FIG. 190.—Diagram to illustrate induplicative or induplicate æstivation, in which the parts of the verticil are slightly turned inwards at the edges.

To the flower-bud the name *alabastrus* is sometimes given, and its period of opening has been called *anthesis*, whilst the manner in which the parts are arranged with respect to each other before opening is the *æstivation* or *præfloration*. The latter terms are applied to the flower-bud in the same way as vernation is to the leaf-bud, and distinctive names have been given to the different arrangements exhibited, both by the leaves individually and in their relations to each other. As regards each leaf of the flower, it is either spread out, as the sepals in the bud of the Lime-tree, or folded upon itself (conduplicate), as in the petals of some species of Lysimachia, or slightly folded inwards or outwards at the edges, as in the calyx of some species of Clematis, and of some herbaceous plants, or rolled up at the edges (involute or révolute), or folded transversely, becoming *crumpled* or *corrugated*, as in the Poppy. When the parts *of a* whorl are placed Plate I.
in an exact circle, and are applied to each other by their edges only, without overlapping or being folded, thus resembling the valves of a seed-vessel, the æstivation is *valvate*, as in the calyx of Guazuma ulmifolia (fig. 189). The edges of each of the parts may be turned either inwards or outwards; in the former case, the æstivation is *induplicate*, as in the corolla of Guazuma ulmifolia (fig. 190), in the latter case, *reduplicate*, as in the calyx of Althæa rosea (fig. 191). When the parts of a single whorl are placed in a circle, each of them exhibiting a torsion of its axis, so that by one of its sides it overlaps its neighbour, whilst its side is overlapped in like manner by that standing next to it, the æstivation *is twisted or contortive*, as in the corolla of Althæa rosea (fig. 192). This arrangement is characteristic of the flower-buds of



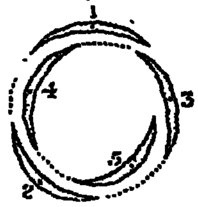
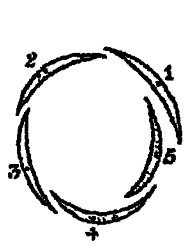


Fig. 191. Fig. 192. Fig. 193.

FIG. 191.—Diagram to illustrate reduplicative or reduplicate æstivation, in which the parts of the whorl are *slightly turned outwards* at the edges.
FIG. 192.—Diagram to illustrate contortive or twisted æstivation, *in* which the parts of the whorl *are overlapped* by each other in turn, and are twisted on their axis.
FIG. 193.—Diagram to illustrate the quincuncial æstivation, in which the parts of the flower are arranged in a *spiral cycle, so that* 1 and 2 are wholly external, 4 and 5 are internal, and 3 is partly external and partly overlapped by 1.

Malvaceæ and Apocynaceæ, and it is also seen in Convolvulaceæ and Caryophyllaceæ. When the flower expands, the traces of twisting *often* disappear, but sometimes, as in Apocynaceæ, they remain. Those forms of æstivation are such as occur in cyclic flowers, and they are included under *circular* æstivation. But in spiral flowers we have a different arrangement, the leaves of the calyx of Camellia japonica cover each other partially like tiles on a house. This æstivation is *imbricate*. At other times, as in the petals of Camellia, the parts envelope each other completely, so as to become *convolute*. This is also seen in a transverse section of the calyx of Magnolia grandiflora, where each of the three leaves embraces that within it. When the parts of a whorl are five, as occurs in many Dicotyledons, and



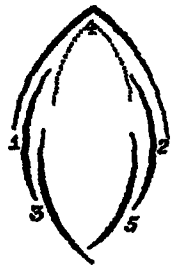


Fig 194. Fig 195.

FIG. 194.—Diagram *to illustrate* imbricative or imbricated æstivation, in which the parts are arranged in a spiral cycle, following the order indicated by the figures 1, 2, 3, 4, 5.
FIG. 195.—Diagram of a papilionaceous flower, showing vexillary æstivation. 1 and 2, the alæ or wings; 3, a part of the carina or keel; 4, the vexillum or standard, which, in place of being internal, as marked by the dotted line, becomes external; 5, *the* remaining part of the keel. The order of the cycle is indicated by the figures.

the imbrication is such that there are two parts external, two internal, and a *fifth* which partially covers one of the internal parts by its margin, and is in its turn partially covered by one of the external parts, the æstivation is *quincuncial* (fig. 193). This quincunx is common in the corolla of Rosaceæ. In fig. 194 a section is given of the

bud of Antirrhinum majus, showing the imbricate spiral arrangement. In this case it will be seen that the part marked 5 has, by a slight change in position, become overlapped by 1. This variety of imbricate æstivation has been termed *cochlear.* In flowers, such as those of the Pea (fig. 187), one of the parts, the vexillum, is often large and folded over the others, giving rise to *vexillary* æstivation (fig. 195), or the carina may perform a similar office, and then the æstivation is *carinal,* as in the Judas-tree (Cercis Siliquastrum). The parts of the several verticils often differ in their mode of æstivation. Thus, in Malvaceæ the corolla is contortive and the calyx valvate, or reduplicate; in St John's-wort the calyx is imbricate, and the corolla contortive. In Convolvulaceæ, while the corolla is twisted, and has its parts arranged in a circle, the calyx is imbricate, and exhibits a spiral arrangement. In Guazuma the calyx is valvate, and the corolla induplicate. The circular æstivation is generally associated with a regular calyx and corolla, while the spiral æstivations are connected with irregular as well as with regular forms.

I. Protective Organs.

1. *Calyx.*

rotective gans. lyx.

The calyx is the external envelope of the flower, and consists of verticillate leaves, called *sepals, foliola,* or *phylla.* These calycine leaves are sometimes separate from each other, at other times they are united to a greater or less extent; in the former case, the calyx is *dialysepalous* or *eleutherosepalous, polysepalous* or *polyphyllous,* or *aposepalous;* in the latter, *gamosepalous* or *gamophyllous, monosepalous* or *monophyllous,* or *synsepalous.* The divisions of the calyx present usually all the characters of leaves, and in some cases of monstrosity they are converted into the ordinary leaves of the plant. Their structure consists of cellular tissue or parenchyma, traversed by vascular bundles, in the form of ribs and veins, containing spiral vessels, which can be unrolled, delicate woody fibres, and other vessels, the whole being enclosed in an epidermal covering, having stomata and often hairs on its outer surface, which corresponds to the under side of the leaf. In the great divisions of the vegetable kingdom the venation of the calyx is similar to that of the leaves,—parallel in Monocotyledons, reticulated in Dicotyledons. The leaves of the calyx are usually entire, but occasionally they are cut in various ways, as in the Rose, and they are sometimes hooked at the margin, as in Rumex uncatus. It is rare to find the leaves of the calyx stalked. They are usually sessile leaves, in which the vaginal portion is only slightly developed, and frequently the laminar part is alone present. Sepals are generally of a more or less oval, elliptical, or oblong form, with their apices either blunt or acute. In their direction they are erect or reflexed (with their apices downwards), spreading outwards (*divergent* or *patulous*), or arched inwards (*connivent*). They are usually of a greenish colour, and are called *foliaceous* or *herbaceous;* but sometimes they are coloured, as in the Fuchsia, Tropæolum, Globe-flower, and Pomegranate, and are then called *petaloid.* Whatever be its colour, the external envelope of the flower must be considered as the calyx. The nature of the hairs on the calyx gives rise to terms similar to those already mentioned as applied to the surfaces of other parts of plants. The vascular bundles sometimes form a prominent rib, which indicates the middle of the sepal; at other times they form several ribs. The venation is useful as pointing out the number of leaves which constitute a gamosepalous calyx. In a polysepalous calyx the number of the parts is marked by Greek numerals prefixed. Thus, a calyx which has three sepals is *trisepalous;* one with five sepals is *pentasepalous* or *pentaphyllous.* The sepals occasionally are of different forms and sizes. In Aconite one of them is shaped like a helmet, and has been called *galeate.* In a gamosepalous calyx the sepals are united in various ways, sometimes very slightly, and their number is marked by the divisions at the apex. These divisions either are simple projections in the form of acute or obtuse teeth; or they extend down the calyx as fissures about halfway, the calyx being *trifid* (three-cleft), *quinquefid* (five-cleft), (fig. 196), &c., according to their number; or they reach to near the base in the form of partitions, the calyx being *tripartite, quadripartite, quinquepartite,* &c. The union of the parts may be complete, and the calyx may be quite entire or *truncate,* as in some Correas, the venation being the chief indication of the different parts. The cohesion is sometimes irregular, some parts uniting to a greater extent than others; thus a two-lipped or *labiate* calyx is formed, which, when the upper or posterior lip is arched, becomes *ringent.* The upper lip is often composed of three parts, which are thus posterior or next the axis, while the lower has two, which are anterior. The part formed by the union of the sepals is called the *tube* of the calyx; the portion where the sepals are free is the *limb.*

Occasionally, certain parts of the sepals undergo marked enlargement. In the Violet the calycine segments (*laciniæ*) are prolonged downwards beyond their insertions, and in the Indian Cress (Tropæolum) this prolongation is in the form of a spur (*calcar*), formed by three sepals; in Delphinium it is formed by one. When one or more sepals are thus enlarged, the calyx is *calcarate* or *spurred.* In Pelargonium the spur from one of the sepals is adherent to the flower-stalk. When an epicalyx is present, as in the Mallow order, the flower appears to be provided with a double calyx, and has been denominated *caliculate.* Degenerations take place in the calyx, so that it becomes dry, scaly, and glumaceous (like the glumes of grasses), as in the Rush tribe; hairy, as in Compositæ; or a mere rim, as in some Umbelliferæ and Acanthaceæ, and in Madder (Rubia tinctorum, fig. 198), when it is called *obsolete* or *marginate.* In Diplolæna it is reduced to five scales. In Compositæ,

Plate III. Plate IX. Plate VII.

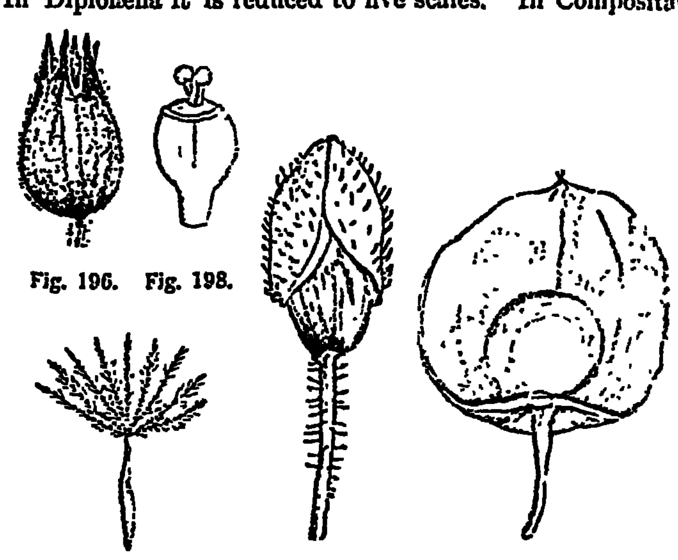


Fig. 196. Fig. 198.

Fig. 197. Fig. 199. Fig. 200.

Fig. 196.—Gamosepalous five-toothed (quinque-dentate) calyx of Campion (*Lychnis*).

Fig. 197.—Feathery pappus attached to the fruit of Salsafy (*Tragopogon porrifolius*). The calyx adheres to the fruit, and its limb is pappose.

Fig. 198.—Calyx of Madder (*Rubia*), adherent to the pistil, its limb appearing in the form of a rim. The calyx is called obsolete.

Fig. 199.—Caducous calyx of Poppy (*Papaver*). It is composed of two sepals, which fall off before the petals expand.

Fig. 200.—Bladder-like calyx of the Winter Cherry (*Physalis Alkekengi*), [illegible] to show the mode in which it surrounds the fruit without adhering to it. The calyx is persistent, but not adherent. It enlarges after the flower withers, and is called accrescent.

Dipsaceæ, and Valerianaceæ, the calyx is attached to the pistil, and its limb is developed in the form of hairs, called *pappus* (fig.197). This pappus is either simple [illegible]

Plate VIII feathery (*plumose*). In Valeriana the superior calyx is at first an obsolete rim, but as the fruit ripens it is shown to consist of hairs rolled inwards, which expand so as to waft the fruit. The calyx sometimes falls off before the flower Plate I. expands, as in Poppies, and is *caducous* (fig. 199); or along with the corolla, as in Ranunculus, and is *deciduous*; or it Plate XI. remains after flowering, as in Labiatæ, Scrophulariaceæ, and Boraginaceæ; or its base only is persistent, as in Datura Stramonium. In Eschscholtzia and Eucalyptus the sepals remain united at the upper part, and become disarticulated at the base or middle, so as to come off in the form of a lid or funnel. Such a calyx is *operculate* or *calyptrate*. The existence or non-existence of an articulation determines the deciduous or persistent nature of the calyx. In the case of Eschscholtzia the axis seems to be prolonged so as Plate II. to form a sort of tube, from which the calyx separates. In Eucalyptus the calyx consists of leaves, the laminæ or petioles of which are articulated like those of the Orange, and the separation between the parts occurs at this articulation. The receptacle bearing the calyx is sometimes united to the pistil, and enlarges so as to form a part of the fruit, as in the Apple, Pear, Pomegranate, Gooseberry, &c. In these fruits the withered calyx is seen at the apex. Sometimes a persistent calyx increases much after flowering, and encloses the fruit without being incorporated with it, becoming *accrescent*, as in various species of Physalis (fig. 200); at other times it remains in a withered or *marcescent* form, as in Erica; sometimes it becomes *inflated* or *vesicular*, as in Sea Campion (Silene maritima).

2. *Corolla.*

Corolla The corolla is the more or less coloured inner floral envelope, forming the whorl of leaves between the calyx and the stamens. It is generally the most conspicuous whorl. The gay colours and fragrant odours of flowers are resident in it. It is present in the greater number of Dicotyledons. Petals differ more from leaves than sepals do, and are much more nearly allied to the staminal whorl. In some cases, however, they are transformed into leaves, like the calyx, and occasionally leaf-buds are developed in their axil. They are seldom green, although occasionally that colour is met with, as in some Cobæas, Hoya viridiflora, Gonolobus viridiflorus, and Pentatropis spiralis. As a rule they are highly coloured, the colouring matter being contained in cells, and differing in its nature from the chlorophyll of the leaves. As regards their structure petals consist of cellular tissue, traversed by true spiral vessels and thin-walled tubes. In delicate flowers, as Convolvulus and Anagallis, these vessels are easily seen under the microscope. Petals do not usually present numerous layers of cells like the leaves, neither is the epidermis always distinct, although in some instances it may be detached, especially from the surface next the calyx. The cuticle of the petal of a Pelargonium, when viewed with a $\frac{1}{2}$ or $\frac{1}{4}$-inch object glass, shows beautiful hexagons, the boundaries of which are ornamented with several inflected loops in the sides of the cells

On the outer surface of petals, corresponding to the lower side of leaves, stomata are sometimes found. Petals are generally glabrous or smooth; but, in some instances, hairs are produced on their surface. Petaline hairs, though sparse and scattered, present occasionally the same arrangement as those which occur on the leaves; thus, in Bombaceæ they are stellate. Coloured hairs are seen on the petals of Menyanthes, and on the segments of the perianth of the Iris. Although petals are usually very thin and delicate in their texture, they occasionally become thick and fleshy, as in Stapelia and Rafflesia; or dry, as in Heaths; or hard and stiff, as in Xylopia. A petal often consists of two portions—the lower narrow, resembling the petiole of a leaf, and called the *unguis* or *claw*; the upper broader, like the blade of a leaf, and called the *lamina* or *limb*. These parts are seen in the petals of the Wallflower (fig. 201), where *c* is the claw and *l* the limb. The claw is often wanting, as in the Crowfoot (fig. 202) and the Poppy, and the petals are Plate I then *sessile*. Petals having a claw are *unguiculate*. According to the development of veins and the growth of cellular tissue, petals present varieties similar to those already noticed in the case of leaves. Thus the margin is either entire or divided into lobes or teeth. These teeth sometimes form a regular fringe round the margin, and the petal becomes *fimbriated*, as in the Pink; or *laciniated*, as in Lychnis Flos-cuculi; or *crested*, as in Polygala. Sometimes the petal becomes pinnatifid, as in Schizopetalum. The median vein is occasionally prolonged beyond the summit

Fig. 201.

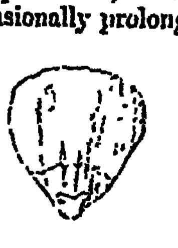


Fig. 202.

Fig. 203.

Fig. 204.

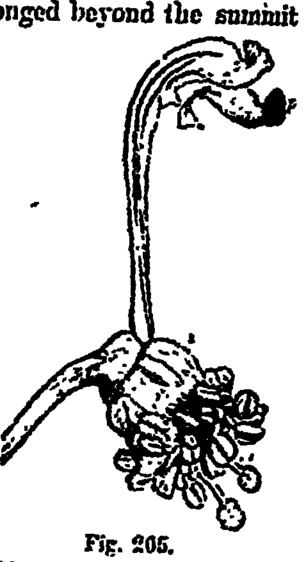


Fig. 205.

FIG. 201.—Unguiculate or stalked petal of Wallflower (*Cheiranthus Cheiri*). *c*, the claw or unguis; *l*, the blade or lamina.
FIG. 202.—Petal of Crowfoot (*Ranunculus*), without a claw, and thus resembling a sessile leaf. At the base of the petal a nectariferous scale is seen.
FIG. 203.—Tubular petal of Hellebore (*Helleborus*), formed by folding and adhesion, in the same manner as pitchers
FIG. 204.—Horn-like hollow petal of Columbine (*Aquilegia vulgaris*), formed by folding and adhesion of the edges.
FIG. 205.—Part of the flower of Aconite (*Aconitum Napellus*), showing two irregular horn-like petals *p*, supported on grooved stalks *o*. These used to be called nectaries. *s*, the whorl of stamens inserted on the thalamus, and surrounding the pistil.

of the petals in the form of a long process, as in Strophanthus hispidus, where it extends for 7 inches; and at other times it ends in a free point or *cuspis*, and the petal becomes *cuspidate*; or the prolonged extremity is folded downwards or inflexed, as in Umbelliferæ, so that the apex approaches the base. The limb of the petal may be flat or concave, or hollowed like a boat. In Hellebore the petals become folded in a tubular form, resembling a horn (fig. 203); in Aconite (fig. 205) some of the petals resemble a hollow-curved horn, supported on a grooved stalk; while in Columbine (fig. 204), Violet, Snapdragon, and Centranthus, one or all of them are prolonged in the form of a spur, and are *calcarate*. In Valeriana, Antirrhinum, and Corydalis, Plate VIII the spur is very short, and the corolla or petal is said to be *gibbous*, or *saccate*, at the base.

A corolla rarely consists of one petal, and when this occurs, as in Amorpha, it depends on the abortion or non-development of others. Such a corolla is *unipetalous*, a term quite distinct from monopetalous. A corolla is *dipetalous*, *tripetalous*, *tetrapetalous*, or *pentapetalous*, according as it has two, three, four, or five separate petals. The general name of *polypetalous*, *dialypetalous*, *eleutheropetalous*, or *apopetalous*, is given to corollas having separate petals, while *monopetalous*, *gamopetalous*, or *sympetalous* is applied to those in which the petals are united. This union generally takes place at the base, and extends more or less towards the apex; in Phyteuma the petals are united at their apices also. In some polypetalous corollas, as that of the Vine, the petals are separate at the base, and

adhere by the apices. When the petals are equal as regards their development and size, the corolla is *regular;* when unequal, it is *irregular.* When a corolla is gamopetalous, it usually happens that the claws are united into a tube, while the upper parts are either free or partially united, so as to form a common limb, the point of union of the two portions being the *faux* or *throat,* which often exhibits a distinct constriction or dilatation. The number of parts forming such a corolla can be determined by the divisions, whether existing as teeth, crenations, fissures, or partitions, or if, as rarely happens, the corolla is entire, by the venation. The union may be equal among the parts, or some may unite more than others.

Amongst regular polypetalous corollas may be noticed the *rosaceous* corolla (fig. 206), in which there are five spreading petals, having no claws, and arranged as in the single Rose and Potentilla; the *caryophyllaceous* corolla, in which there are five petals with long narrow tapering claws, as in many of the Pink tribe; the *alsinaceous,* where the claw is less narrow, and there are distinct spaces between the petals, as in some species of Chickweed; the *cruciform,* having four petals, often unguiculate, placed opposite in the form of a cross, as seen in Wallflower, and in other plants called *cruciferous.* Of irregular polypetalous corollas the
V. most marked is the *papilionaceous* (fig. 187), in which there are five petals:—one superior (posterior), *st,* placed next to the axis, usually larger than the rest, called the *vexillum* or *standard;* two lateral, *a,* the *alæ* or wings; two inferior (anterior), partially or completely covered by the alæ, and often united slightly by their lower margins, so as to form a single keel-like piece, *car,* called *carina* or keel, which embraces the essential organs. This form of corolla is characteristic of British Leguminous plants. Among the irregular polypetalous corollas might be included the *orchideous* (fig. 207), although it is really the perianth of a Monocotyledon. This perianth consists of three outer portions equivalent to the calyx, and three inner parts alternating with them, constituting the petals. The latter are often very irregular, some being spurred, others hooded, &c.; and there is always one, called the *labellum* or lip *l,* which presents a remarkable development, and gives rise to many of the anomalous forms exhibited by these flowers.

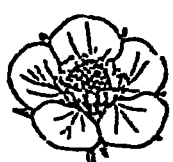


Fig. 206.

Fig. 207.

Fig. 208.

FIG. 206.—Rosaceous corolla of the Strawberry (*Fragaria vesca*), composed of five petals without claws.
FIG. 207.—Flower of Twayblade (*Listera ovata*), seen in front, showing a large bifid labellum *l,* which is different from the other five divisions of the perianth. The divisions of the perianth are in two rows of three each. The essential organs of reproduction are placed on a column opposite the labellum. The perianth is irregular polyphyllous, and is denominated orchideous.
FIG. 208.—Regular gamopetalous bell-shaped (campanulate) corolla of Harebell (*Campanula rotundifolia*). It is composed of five petals united. The ovary is inferior, and is united to the calyx *c.*

Regular gamopetalous corollas are sometimes *campanulate* or *bell-shaped,* as in Campanula rotundifolia (fig. 208): *infundibuliform* or *funnel-shaped,* when the tube is like an inverted cone, and the limb becomes more expanded at the apex, as in Tobacco; *hypocrateriform* or *salver-shaped,* when there is a straight tube surmounted by a flat spreading limb, as in Primula (fig. 209); *tubular,* having a long cylindrical tube, appearing continuous with the limb, as in Spigelia and Comfrey; *rotate* or *wheel-shaped,* when the tube is very short, and the limb flat and spreading, as in Myosotis (when the divisions of the rotate corolla are very acute, as in Galium, it is sometimes called *stellate* or *star-like*); *urceolate* or *urn-shaped,* when there is scarcely any limb, and the tube is narrow at both ends, and expanded in the middle, as in Bell-heath (Erica cinerea). Some of these forms may become irregular in consequence of certain parts being more developed than others. Thus, in Veronica, the rotate corolla has one division much smaller than the rest, and in Digitalis there is a slightly irregular campanulate corolla which some have called *digitaliform.* Plate XI.
Of irregular gamopetalous corollas there may be mentioned the *labiate* or *lipped* (fig. 210), having two divisions of the limb in the form of what are called *labia* or lips (the upper one, *u,* composed usually of two united petals, and the lower, *l,* of three), separated by a *hiatus* or gap. In such cases the tube varies in length, and the parts in their union follow the reverse order of what occurs in the calyx, where two sepals are united in the lower lip, and three in the upper. When the upper lip of a labiate corolla is much arched, and the lips separated by a distinct gap, it is called *ringent* (fig. 210). The labiate corolla characterizes the

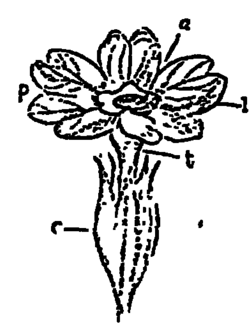


Fig. 209.

Fig. 210.

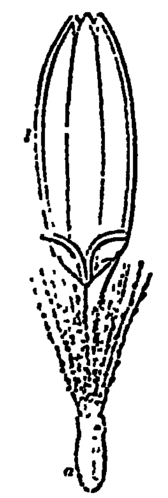


Fig. 211.

FIG. 209.—Regular gamopetalous sympetalous hypocrateriform corolla of Oxlip (*Primula elatior*). *c,* calyx; *p,* corolla; *t,* tube of corolla; *l,* limb; *a,* anthers.
FIG. 210.—Irregular gamopetalous labiate corolla of the Dead-nettle (*Lamium album*). The upper lip *u* is composed of two petals united, the lower lip *l,* of three. Between the two lips (labia) there is a gap (hiatus). The throat is the part where the tube and the labiate limb join. From the arching of the upper lip this corolla is called ringent.
FIG. 211.—Irregular gamopetalous ligulate flower of Ragwort (*Senecio*). It is a tubular floret, split down on one side, with the united petals forming a strap-like projection *l.* The lines on the flat portion indicate the divisions of the five petals. From the tubular portion below, the bifid style projects slightly. The terete fruit (achænium) *a* is surmounted by silky pappus, which is the metamorphosed calycine limb. The flower is female, having no stamens.

natural order Labiatæ. When the lower lip is pressed against the upper, so as to leave only a chink or *rictus* between them, the corolla is said to be *personate* or *mask-like,* as in Frogsmouth, Snapdragon, and some other Scrophulariaceæ, and the projecting portion of the lower lip is called the *palate.* In some corollas the two lips become hollowed out in a remarkable manner, as in Calceolaria, assuming a slipper-like appearance, similar to what occurs in the labellum of some Orchids, as Cypripedium. The *calceolate* corolla of Calceolaria may be considered as consisting of two slipper-like lips. When a tubular corolla is split in such a way as to form a strap-like process on one side with several tooth-like projections at its apex, it becomes *ligulate,* or *strap-shaped* (fig. 211).

This corolla occurs in many Composite plants, as in the florets of Dandelion, Daisy, and Chicory. The number of divisions at the apex indicates the number of united petals, some of which, however, may be abortive. Occasionally some of the petals become more united than others, and then the corolla assumes a *bilabiate*, or two-lipped form, as seen in the division of Compositæ called Labiatifloræ. Plate IX.

In Grasses and Sedges, in place of verticillate leaves forming the flower, there are alternate scales or glumes. The flowers of Grasses usually occur in spikelets (fig. 212), which consist of one or two glumes *a*, covering several flowers *b*. The spikelets are associated in spikes or panicles. In Wheat these spikelets are arranged alternately along a common rachis. Each spikelet consists of two empty glumes *a*, *a*, having the form represented in fig. 212, and enclosing flowers composed of scales (*paleæ*

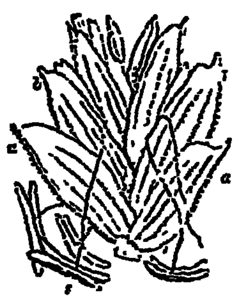


Fig. 212.


Fig. 213.

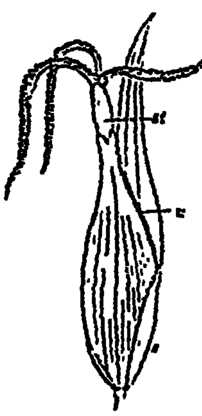


Fig. 214.

FIG. 212.—A spikelet of Wheat (*Triticum*), consisting of two glumes *a*, *a*, enclosing several flowers *b*, *b*, which are composed of two pales (paleæ) covering the essential organs of reproduction. The stamens *s* hang out by long, slender, thread-like filaments. The individual glumes and paleæ are placed alternately on the floral axis.

FIG. 213.—Flower of Oat (*Avena sativa*), with the two glumes, and the outer glumella or palea removed. The inner glumella, flowering glume, or palea *pi*, is seen, of a lanceolate form, and bidentate at the apex. By removing the outer glumella there are seen two *scales* (lodiculæ, squamæ) *sq*, with the three stamens and two feathery styles.

FIG. 214.—Pistilliferous or pistillate flower of a Sedge (*Carex*) with a single glume or scale *s*. The pistil is covered by an urceolate glumaceous bag *u*, called perigynium. There is one style *st*, with three stigmas at its summit.

or *glumellæ*), which are placed at different heights in an alternate manner. In the flower of the Oat (fig. 213), after removing the outer pale or *glumellæ*, the inner one *pi* is seen with two scales (*lodiculæ* or *squamæ*) *sq*, at the base, enclosing the essential organs of reproduction. The paleæ of grasses are called by some flowering glumes, while hypogynous scales (lodiculæ) within them are considered as the rudimentary perianth. In Wheat (Triticum) there are two empty glumes and two flowering glumes, or, as some say, one flowering glume and one pale. In the Oat (Avena) there are two empty glumes, usually three flowering glumes with awns, and two lodicules representing the perianth. In Sedges (Carices) the male flowers are borne on scales, and so are the female, as shown in fig. 214, in which the scale *s* is placed on one side. Within the scale the female flower is situated, having a peculiar bag-like covering *u*, termed perigynium.

The parts of the corolla frequently adhere to those of the calyx, and any change in the latter causes also an alteration in the former. Petals are sometimes suppressed, and sometimes the whole corolla is absent. In Amorpha and Afzelia the corolla is reduced to a single petal, and in some other Leguminous plants it is entirely wanting. In the natural order Ranunculaceæ, some genera, such as Ranunculus, Globe-flower, and Pæony, have both calyx and corolla, while others, such as Clematis, Anemone, and Caltha, have only a coloured calyx. Flowers become double by the multiplication of the parts of the corolline whorl. This arises in general from a metamorphosis of the stamens. Union of separate flowers (*synanthos*) occasionally occurs, and the adhesion which thus takes place causes various changes in the whorls. Flowers may be united by their peduncles, as seen in some anomalous specimens of Dandelion, Hyacinth, and Centaury; or by their outer parts, such as the calyx. At other times there is a complete fusion, as it were, of all the parts of the flowers, some continuing normal, others being suppressed or abortive.

Certain abnormal appearances occur in the petals of some flowers, which received in former days the name of *nectaries*. Nectaries.
The term nectary was very vaguely applied by Linnæus to any part of the flower which presented an unusual aspect, as the crown (*corona*) of Narcissus, the fringes of the Passion-flower, &c. If the name is retained it ought properly to include only those parts which secrete a honey-like matter, as the glandular depression at the base of the perianth of the Fritillary, or on the petal of Ranunculus, or on the stamens of Rutaceæ. The honey secreted by flowers attracts insects, which, by conveying the pollen to the stigma, effect fertilization. What have usually, however, been called nectaries, are mere modifications of some part of the flower, especially of the corolla and stamens, produced either by degeneration or outgrowth, or by *dilamination*, *chorisis*, or *deduplication*. Of this nature are the scales on the petals in Lychnis, Silene, Cynoglossum, and Ranunculus (fig. 202). Others consider these outgrowths of the petal to be formed in the same way as the ligules of Grasses. Corollas having these scaly appendages are sometimes denominated *appendiculate*. In Cuscuta and Samolus Plate I.
the scales are alternate with the petals, and may represent altered stamens. The parts formerly called nectaries are mere modifications of the corolla or stamens. Thus the so-called horn-like nectaries under the galeate sepal of Aconite (fig. 205) are modified petals, so also are the tubular nectaries of Hellebore (fig. 203). The nectaries of Menyanthes and of Iris consist of hairs developed on the petals. Those of Parnassia and the Passion-flower, Stapelia, Asclepias, and Canna, are fringes, rays, and processes, which are probably modifications of stamens; and some consider the crown of Narcissus as consisting of a membrane similar to that which unites the stamens in Pancratium. It is sometimes difficult to say whether these nectaries are to be referred to the corolline or to the staminal row. The paraphyses of the Passion-flower, the crown of Narcissus, and the coronet of Stapelia are referred sometimes to the one and sometimes to the other. In general, they may be said to belong to that series with which they are immediately connected. Some have given names indicating the parts of which they are modifications, by prefixing the term *para*, using such terms as *paracorolla* and *parastemones*.

Petals are attached to the axis usually by a narrow base, but occasionally the base is larger than the limb, as in the Orange flower. When this attachment takes place by an articulation, the petals fall off either immediately after expansion (*caducous*), or after fertilization (*deciduous*). A corolla which is continuous with the axis and not articulated to it, as in Campanula and Heaths, may be persistent, and remain in a withered or marcescent state while the fruit is ripening. A gamopetalous corolla falls off in one piece; but sometimes the base of the corolla remains persistent, as in Rhinanthus and Orobanche.

II. ESSENTIAL ORGANS.

These organs are the *stamens* and the *pistil*, the latter Essential organs.
containing the seeds or germs of young plants, and corresponding to the female, while the former produces a powder necessary for fecundation, and is looked upon as performing part of the male. The presence of both is required in

order that perfect seed may be produced. A flower may have a calyx and corolla, but it will be imperfect if the essential organs are not present. The name of *hermaphrodite* or *bisexual* is given to flowers in which both these organs are found; that of *unisexual* or *diclinous* to those in which only one of these organs appears,—those bearing stamens only, being *staminiferous* or male; those having the pistil only, *pistilliferous* or female. But even in plants with hermaphrodite flowers it is rare that self-fertilization takes place, and this is provided against by the structure of the parts or by the period of ripening of the organs. For instance, in Primula and Linum some flowers have long stamens and a pistil with a short style, the others having short stamens and a pistil with a long style. The former occur in what are called thrum-eyed Primroses, the latter in those called pin-eyed. Such plants are called *dimorphic*. Other plants are *trimorphic*, as species of Lythrum, and proper fertilization is only effected by combination of parts of equal length. In some plants the stamens are perfected before the pistil; they are called *proterandrous*, as in Ranunculus repens, Silene maritima, Zea Mays. In other plants the pistil is perfected before the stamens, as in Potentilla argentea, Plantago major, Coix Lachryma, and they are *proterogynous* plants. Plants in which proterandry or proterogyny occurs are called *dichogamous*. When in the same plant there are unisexual flowers, both male and female, the plant is said to be *monœcious* or *monoicous*, as in the Hazel and Castor-oil plant. This is indicated by the symbol ♂ – ♀. When the male and female flowers of a species are found on separate plants, the term *diœcious* or *dioicous* is applied, as in Mercurialis and Hemp, and the symbol ♂ : ♀ is used; and when a species has male, female, and hermaphrodite flowers on the same or different plants, as in Parietaria, it is *polygamous*, for which ♂ ♀ ☿ is the symbol.

1. *Male Organs in Phanerogams.*

The stamens (*stamina*) arise from the thalamus or torus within the petals, with which they alternate, forming one or more verticils or whorls, which collectively constitute the *andrœcium*, or the male organs of the plant. Their normal position is below the inner whorl or the pistil, and when they are so placed (fig. 215, *e*) upon the thalamus they are *hypogynous*. Sometimes they become adherent to the petals, or are *epipetalous*, and the insertion of both is looked upon as similar, so that they are still hypogynous provided they are independent of the calyx and the pistil. Frequently the margins of the thalamus bearing the floral envelopes and stamens elongates, and the gynœcium remains in the centre of the concave receptacle; thus the stamens as it were rise from the calyx, and they surround the ovary, and are *perigynous*; but when the ovary becomes completely inferior by the growing upwards and inwards of the receptacle, the parts of the flower rising from its summit, the stamens are *epigynous* (fig. 216). Numerous intermediate forms occur, especially amongst Saxifragaceæ, where the parts are *half superior* or *half inferior*. In the Orchis tribe, where the stamens become adherent to the pistil so as to form a column, the flowers are said to be *gynandrous*. The same is the case in Aristolochia (fig. 217). These arrangements of parts are of great importance in classification. The stamens vary in number, from one to many hundreds. Like the other parts of the flower they are modified leaves, resembling leaves in their structure, development, and arrangement. They consist of cellular and vascular tissues. They appear at first in the form of cellular projections, and are arranged in a more or less spiral form. In their general aspect they have a greater resemblance to petals than to the leaves, and there is often seen a gradual transition from petals to stamens, especially in spiral flowers, as Nymphæa alba. When flowers become double by cultivation, the stamens are converted into petals, as in the Pæony, Camellia, Rose, &c. When there is only one whorl the

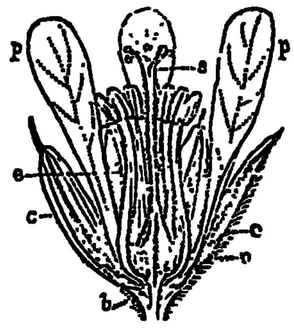


Fig. 215.

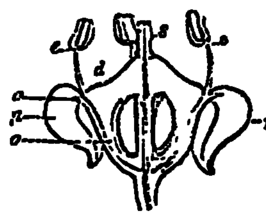


Fig. 216

Fig. 217.

FIG. 215.—Section of a flower of *Geranium Robertianum*. *c*, *c*, calyx; *p*, petals; *e*, stamens. The pistil is composed of ovary *o*, and style and stigmata *s*. *t* is the torus or thalamus. The petals and stamens are hypogynous, and the latter are monadelphous.

FIG. 216.—Section of the flower of *Aralia spinosa*. Letters as in last figure. The petals and stamens are epigynous, attached to the torus *d*, which covers the summit of the ovary. The ovary is adherent to the torus, and has been laid open to show its loculaments and pendulous ovules.

FIG. 217.—Essential organs of Birthwort (*Aristo'ochia*). Above the ovary *b*, are the stamens united in a column with the style at *a*, so as to be gynandrous. On the summit is the stigma above the stamens.

stamens are usually equal in number to the sepals or petals, and are arranged opposite to the former, and alternate with the latter. The flower is then *isostemonous*. When the stamens are not equal in number to the sepals or petals, the flower is *anisostemonous*. When there is more than one whorl of stamens, then the parts of each successive whorl alternate with those of the whorl preceding it. The staminal row is more liable to multiplication of parts than the outer whorls. A flower with a single row of stamens is *aplostemonous*. If the stamens are double the sepals or petals as regards number, the flower is *diplostemonous*; if more than double, *polystemonous*. The additional rows of stamens may be developed in the usual centripetal (acropetal) order, as in Rhamnaceæ; or they may be interposed between the pre-existing ones or be placed outside them, *i.e.*, develop centrifugally (basipetally), as in Geranium and Oxalis. When the stamens are neither equal to, nor a multiple of, the floral envelopes, but are less numerous, the flower is *miostemonous*. When the stamens are fewer than twenty they are said to be *definite*, and the flower is *oligandrous*; when above twenty they are *indefinite* or *polyandrous*, and are represented by the symbol ∞. The number of stamens is indicated by the Greek numerals prefixed to the term *androus*; thus a flower with

1 stamen is Monandrous (Hippuris, Centranthus);
2 stamens is Diandrous (Veronica, Calceolaria, Circæa);
3 stamens is Triandrous (Grasses, Iris, Valeriana);
4 stamens is Tetrandrous (Alchemilla, Galium, Plantago);
5 stamens is Pentandrous (Primula, Umbelliferæ, Campanula);
6 stamens is Hexandrous (Tulip, Lilium, Juncus);
7 stamens is Heptandrous (Trientalis, Horse-chestnut);
8 stamens is Octandrous (Heath, Fuchsia, Epilobium);
9 stamens is Enneandrous (Butomus, some Lauraceæ);
10 stamens is Decandrous (Saxifraga, Dianthus, Oxalis);
12 stamens is Dodecandrous (Asarum, Agrimonia, Reseda);
20 stamens is Icosandrous (Strawberry, Potentilla, Cratægus);
Numerous and indefinite stamens is Polyandrous ∞ (Poppy).

The simplest form of stamens is seen in Cycadaceous plants, where cataphyllary leaves (the scales of the cone) [illegible] are the staminal leaves, bearing the pollen-sacs scattered over their under surface. The stamen usually consists of two parts, a contracted portion, often thread-like, termed the

filament (fig. 175, *f*), and a broader portion, usually of two lobes, termed the *anther* (fig. 175, *a*), containing a powdery matter, called *pollen* (*p*), and supported upon the end of the filament. That portion of the filament in contact with the anther lobes is termed the *connective*. The exact morphological relations of these parts is not definitely settled. Some consider the filament as representing the petiole, and the anther as being the folded lamina; others again regard the connective as representing the lamina, the rest of the filament being the petiole, and the anther lobes as mere appendages of the lamina. The filament is no more essential to the stamen than the petiole is to the leaf, or the claw to the petal. If the anther is absent the stamen is abortive, and cannot perform its functions. The anther is developed before the filament, and when the latter is not produced, the anther is sessile, or has no stalk, as in the Mistleto.

The filament.

The *filament*, when structurally considered, is found to consist of a thin epidermis, on which occasionally stomata and hairs occur, and a layer of cellular tissue enclosing a bundle of spiral vessels, which traverses its whole length, and terminates at the junction between the filament and the anther. The filaments of Callitriche verna are said to have no vessels. The filament is usually, as its name imports, filiform or thread-like, cylindrical, or slightly tapering towards its summit. It is often, however, thickened, compressed, and flattened in various ways, becoming *petaloid* in Canna, Maranta, Nymphæa alba (fig. 179); *subulate* or slightly broadened at the base, and drawn out into a point like an awl, as in Butomus umbellatus; *clavate*, that is, narrow below and broad above, as in Thalictrum. In some instances, as in Tamarix gallica, Peganum Harmala, and Campanula, the base of the filament is much dilated, and ends suddenly in a narrow thread-like portion. In these cases the base may represent the sheath or vagina of the leaf, and may give off stipulary processes in a lateral direction, as in Allium and Alyssum calycinum. The filament varies much in length and in firmness. The length sometimes bears a relation to that of the pistil, and to the position of the flower, whether erect or drooping. The filament is usually of sufficient solidity to support the anther in an erect position; but sometimes, as in Grasses, it is very delicate and capillary, or hair-like, so that the anther is pendulous (fig. 212, *s*). The filament is generally continuous from one end to the other, but in some cases it is bent or jointed, becoming *geniculate*; at other times, as in the Pellitory, it is spiral. It is frequently colourless; but, in many instances, it exhibits different colours. In Fuchsia and Poinciana, it is red; in Adamia and Tradescantia virginica, blue; in Œnothera and Ranunculus acris, yellow.

Hairs, scales, teeth, or processes of different kinds are sometimes developed on the filament. In Tradescantia virginica, or Spiderwort, the hairs are beautifully coloured, moniliform or necklace-like, and *rotation* is seen in them (p. 84). Such a filament is bearded or *stupose*. At the base of the filament glandular or scaly appendages are occasionally produced, either on its internal or its external surface. These may be either parts of a whorl, to be afterwards noticed under the name of the disk, or separate prolongations from the filament itself, which is hence called *appendiculate*, or sometimes *strumose*. Filaments are usually articulated to the thalamus or torus, and the stamens fall off after fertilization; but in Campanula and some other plants they are continuous with the torus, and the stamens remain persistent, although in a withered state. Changes are produced in the whorl of stamens by cohesion of the filaments to a greater or less extent, while the anthers remain free; thus, all the filaments of the andrœcium may unite, forming a tube round the pistil, or a central bundle when the pistil is abortive, the stamens becoming *monadelphous*, as occurs in plants of the Mallow tribe; or Plate III. they may be arranged in two bundles, the stamens being *diadelphous*, as in Polygala, Fumaria, and Pea; in this case the bundles may be equal or unequal. It frequently happens, especially in Papilionaceous flowers, that out of ten stamens nine are united by their filaments, while one (the posterior one) is free (fig. 218). When there are three or more bundles the stamens are *triadelphous*, as in Hypericum ægyptiacum, or *polyadelphous*, as in Luhea paniculata and Ricinus communis. In some cases, especially in the Mallow tribe, the stamens cohere, having been originally separate, but in most other cases each bundle is produced by the branching of a single stamen. When there are three stamens in a bundle we may conceive the lateral ones as of a stipulary nature. In Lauraceæ there are perfect stamens, each having at the base of the filament two abortive stamens or staminodes, which may be analogous to stipules. Filaments sometimes are adherent to the pistil, forming a *columna* or column, as in Stylidium, Asclepiadaceæ, Rafflesia, Orchidaceæ, and Aristolochiaceæ (fig. 217). The column is called *gynostemium*, and the flowers are denominated *gynandrous*.

The anther.

The *anther* consists of lobes containing minute powdery matter, called *pollen*, which, when mature, is discharged by a fissure or opening of some sort. The anther-lobes are considered by some as formed by the two halves of the lamina, their back corresponding to the under surface, and their face to the upper surface, united by the midrib, the pollen being the cellular tissue, and the fissure of the anther taking place at the margin, which, however, is often turned towards the face. In this view, the two cavities which are found to exist in each lobe may correspond with the upper and under layer of cells, separated by a septum equivalent to the fibro-vascular layer of the leaf. Others view the anther as formed by each half of the lamina being folded upon itself, so that the outer surface of both face and back corresponds to the lower side of the leaf, and the septum dividing each cavity into two is formed by the united upper surfaces of the folded half. Again, others hold that the connective represents the lamina of the leaf to which the anther lobes are mere appendages. There is a double covering of the anther—the outer, or *exothecium*, resembles the epidermis, and often presents stomata and projections of different kinds (fig. 219); the inner, or *endothecium*, is

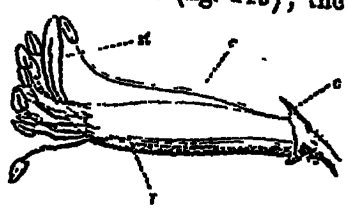


Fig. 218.

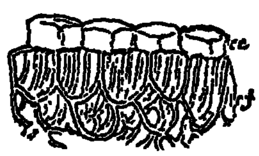


Fig. 219.

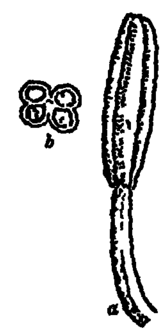


Fig. 220.

FIG. 218.—Stamens and pistil of Sweet Pea (*Lathyrus*). The stamens are diadelphous, nine of them being united by their filaments *f*, while one of them, *c*, is free; the upper part of the pistil is marked *st*, the calyx, *c*.

FIG. 219.—Broken-down fibrous cells *cf* of the endothecium of the anther of the Melon. The walls of the cells are absorbed, and the fibres are set free. The exothecium or outer epidermis is marked *ce*.

FIG. 220.—Quadrilocular or tetrathecal anther of the flowering Rush (*Butomus umbellatus*). The anther entire, *a*, with its filament; section of anther, *b*, showing the four loculi.

formed by a layer or layers of cellular tissue (fig. 219, *cf*), the cells of which have a spiral, annular, or reticulated fibre in their interior. This internal lining varies in thickness,

generally becoming thinner towards the part where the anther opens, and there disappears entirely. The walls of the cells are frequently absorbed, so that when the anther attains maturity the fibres are alone left, and these by their elasticity assist in discharging the pollen. The anther is developed before the filament, and is always sessile in the first instance, and sometimes continues so. It appears at first as a simple cellular papilla of meristem, upon which an indication of two lobes soon appears. Upon these projections the rudiments of the pollen-sacs are then seen, usually four in number, two on each lobe. In each a differentiation takes place in the layers beneath the epidermis, by which an outer layer of small-celled tissue surrounds an inner portion of large cells. Those central cells are the mother-cells of the pollen, whilst the small-celled layer of tissue external to them becomes the endothecium, the exothecium being formed from the epidermal layer.

In the young state there are usually four pollen-sacs or cavities produced, two for each anther-lobe, and when these remain permanently complete, it is a *quadrilocular* or *tetrathecal* anther (fig. 220). The four cavities are sometimes placed in apposition, as in Poranthera, and Tetratheca juncea, and at other times two are placed above and two below, as in Persea gratissima. Sometimes, however, only two cavities remain in the anther, by union of the sacs in each lobe, in which case the anther is said to be *bilocular* or *dithecal*. Sometimes the anther has a single cavity, and becomes *unilocular*, or *monothecal*, or *dimidiate*, either by the disappearance of the partition between the two lobes, or by the abortion of one of its lobes, as in Styphelia læta and Althæa officinalis. Occasionally there are numerous cavities in the anther, as in Viscum and Rafflesia. The form of the anther-lobes varies. They are generally of a more or less oval or elliptical form, or they may be globular, as in Mercurialis annua; at other times linear or clavate, curved, flexuose, or sinuose or *anfractuose*, as in Bryony and Gourd. According to the amount of union of the lobes and the unequal development of different parts of their surface an infinite variety of forms are produced. That part of the anther to which the filament is attached, and which is generally towards the petals, is the *back*, the opposite being the *face*. The division between the lobes is marked on the face of the anther by a groove or *furrow*, and there is usually on the face a *suture*, indicating the line where the membranous coverings open to discharge the pollen. The suture is often towards one side in consequence of the valves being unequal. The stamens may cohere by their anthers, and become *syngenesious* or *synantherous*, as in Composite flowers, and in Lobelia, Jasione, Viola, &c.

The anther-lobes are united to the *connective*, which may be either continuous with the filament or articulated with it. It consists of parenchyma, in which the spiral vessels of the filament terminate. From the connective a partition or *septum* extends across each antherine loculus, dividing it either partially or completely. The septum sometimes reaches the suture When the filament is continuous with the connective, and is prolonged so that the anther-lobes appear to be united to it throughout their whole length, and lie in apposition to it and on both sides of it, the anther is said to be *adnate* or *adherent*; when the filament ends at the base of the anther, then the latter is *innate* or *erect*. In these cases the anther is to a greater or less degree fixed. When, however, the attachment is very narrow, and an articulation exists, the anthers are movable, and are easily turned by the wind. This is well seen in what are called *versatile* anthers, as in Tritonia, Grasses, &c. (fig. 212), where the filament is attached only to the middle of the connective; and it may occur also in cases where it is attached to the apex, as in pendulous anthers. The connective may unite the anther-lobes completely, or only partially. It is sometimes very short, and is reduced to a mere point, so that the lobes are separate or free. At other times it is prolonged upwards beyond the lobes, assuming various forms, as in Acalypha, and Nerium Oleander; or it is extended backwards and downwards, as in Violet (fig. 221), and Ticorea febrifuga. In Salvia officinalis the connective is attached to the filament in a horizontal manner, so as to separate the two anther-lobes, and then it is called *distractile* (fig. 222); one of the lobes only being perfect or fertile, containing pollen, the other imperfectly developed and sterile. In Stachys the connective is expanded laterally, so as to unite the bases of the antherine lobes, and bring them into a horizontal line.

The opening of the anthers to discharge their contents is denominated *dehiscence*. This takes place either by clefts, by hinges, or by pores. When the anther-lobes are erect, the cleft takes place lengthwise along the line of the suture, constituting *longitudinal dehiscence* (fig. 175). At other times the slit takes place in a horizontal manner, from the connective to the side, as in Alchemilla arvensis (fig. 223) and in Lemna; the dehiscence is then *transverse*. When the anther-lobes are rendered horizontal by the enlargement of the connective, then what is really longitudinal dehiscence may appear to be transverse. In other cases, when the lobes are united at the base, the fissure in each of them may be continuous, and the two lobes may appear as one. The cleft does not always proceed the whole length of the anther-lobe at once, but often for a time it extends only partially. In other instances the opening is confined to the base or apex, each loculament opening by a single pore, as in Pyrola, Tetratheca juncea, Rhododendron, Vaccinium, and Solanum (fig. 224), where there are Antherine dehiscence.

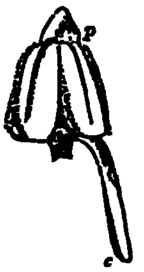


Fig. 221.


Fig. 223.

Fig. 224.

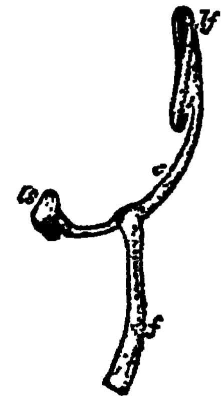


Fig. 222.


Fig. 225.

Fig. 221.—Two stamens of Pansy (*Viola tricolor*), with their two anther-lobes and the process *p* extending beyond them. One of the stamens has been deprived of its spur, the other shows its spur, *c*.

Fig. 222.—Anther of *Salvia officinalis*. *f*, fertile lobe full of pollen; *s*, barren lobe without pollen; *c*, distractile connective; *f*, filament.

Fig. 223.—Stamen of Lady's Mantle (*Alchemilla*), with the anther opening transversely.

Fig. 224.—Stamen of a species of Nightshade (*Solanum*), showing the [illegible] of the anther-lobes at the base, and the dehiscence by pores at the apex *a*.

Fig. 225.—The stamen of the Barberry (*Berberis vulgaris*), showing one of the valves of the anther *v*, curved upwards, bearing the pollen on its inner surface.

two, and Poranthera, where there are four; whilst in the Mistleto the anther has numerous pores for the discharge of the pollen. Another mode of dehiscence is called

hinged. In the Barberry (fig. 225) each lobe opens by a valve on the outer side of the suture, separately rolling up from base to apex; in some of the Laurel tribe there are two such valves for each lobe, or four in all. This may be called a combination of transverse and hinged dehiscence. In some Guttiferæ, as Hebradendron cambogioides (the Ceylon Gamboge plant), the anther opens by a lid separating from the apex; this is called *circumscissile* dehiscence.

The anthers dehisce at different periods during the process of flowering; sometimes in the bud, but more commonly when the pistil is fully developed, and the flower is expanded. They either dehisce simultaneously or in succession. In the latter case individual stamens may move in succession towards the pistil and discharge their contents, as in Parnassia palustris, or the outer or the inner stamens may first dehisce, following thus a centripetal or centrifugal order. The anthers are called *introrse* or *anticæ*, when they dehisce by the surface next to the centre of the flower; they are *extrorse*, or *posticæ*, when they dehisce by the outer surface; when they dehisce by the sides, as in Iris and some grasses, they are *laterally* dehiscent. Sometimes, from their versatile nature, anthers originally introrse become extrorse, as in the Passion-flower and Oxalis.

The usual colour of anthers is yellow, but they present a great variety in this respect. They are red in the Peach, dark purple in the Poppy and Tulip, orange in Eschscholtzia, &c. The colour and appearance of the anthers often change after they have discharged their functions.

Stamens occasionally become sterile by the degeneration or non-development of the anthers. Such stamens receive the name of *staminodia*, or rudimentary stamens. In Scrophularia the fifth stamen appears in the form of a scale; and in many Pentstemons it is reduced to a filament with hairs or a shrivelled membrane at the apex. In other cases, as in double flowers, the stamens are converted into petals; this is also probably the case with such plants as Mesembryanthemum, where there is a multiplication of petals in several rows. Sometimes, as in Canna, one of the anther-lobes becomes abortive, and a petaloid appendage is produced. Stamens vary in length as regards the corolla. Some are enclosed within the tube of the flower, as in Cinchona, and are called *included;* others are *exserted*, or extend beyond the flower, as in Littorella, Plantago, and Exostemma. Sometimes the stamens in the early state of the flower project beyond the petals, and in the progress of growth become included, as in Geranium striatum. Stamens also vary in their relative lengths as respects each other. When there is more than one row or whorl in a flower, those on the outside are sometimes longest, as in many Rosaceæ; at other times those in the interior are longest, as in Luhea. When the stamens are in two rows, those opposite the petals are usually shorter than those which alternate with the petals. It sometimes happens that a single stamen is longer than all the rest. A definite relation, as regards number, sometimes exists between the long and the short stamens. Thus, in some flowers the stamens are *didynamous*, having only four out of five stamens developed, and the two corresponding to the upper part of the flower longer than the two lateral ones. This occurs in Labiatæ and Scrophulariaceæ

Plate XI. (fig. 226). Again, in other cases, there are six stamens, whereof four long ones are arranged in pairs opposite to each other, and alternate with two isolated short ones (fig. 227), giving rise to *tetradynamous* flowers, as in Cruciferæ. Stamens, as regards their direction, may be erect, turned inwards, outwards, or to one side. In the last-mentioned case they are called *declinate*, as in Amaryllis, Horse-chestnut, and Fraxinella.

The *pollen* or powdery matter contained in the anther consists of small cells developed in the interior of other cells. These are produced in the large thick-walled mother Pollen.

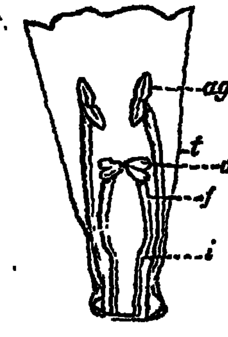


Fig. 226.

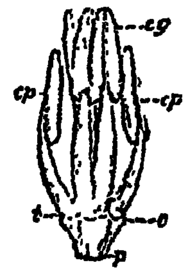


Fig. 227.

FIG. 226.—Corolla of *Digitalis purpurea*, cut in order to show the didynamous stamens (two long and two short) which are attached to it. *t*, tube; *f*, filaments which are united to the corolla at *i*, and run along its inner surface, having formed a marked adhesion; *ag*, anthers of the long stamens: *ag*, anthers of the short stamens.

FIG. 227—Tetradynamous stamens (four long and two short) of *Cheiranthus Cheiri*. *p*, top of the peduncle: *c*, cicatrices left by the sepals of calyx which have been removed: *cg*, two pairs of long stamens; *cp* the short stamens: *t*. torus or thalamus to which the stamens are attached.

cells or pollen utricles, formed in the interior of the pollen-sacs of the young anther. These mother-cells are either separated from one another and float in the granular fluid which fills up the cavity of the pollen-sac, or are not so isolated. A division takes place, by which four cells are formed in each, the exact mode of division differing in Dicotyledons and Monocotyledons. These cells are the pollen-cells or grains. They increase in size and acquire a cell-wall, which becomes differentiated into an outer cuticular layer, or *extine*, and an inner layer, or *intine*. Then the walls of the mother-cells are absorbed, and the pollen-grains float freely in the fluid of the pollen-sacs, which gradually disappears, and the mature grains form a powdery mass within the anther. They then either remain united in fours, or multiples of four, as in some Acacias, Periploca græca, and Inga anomala, or separate into individual grains, which by degrees become mature pollen. Occasionally the membrane of the pollen-cell is not completely absorbed, and traces of it are detected in a viscous matter surrounding the pollen-grains, as in Onagraceæ. In Orchidaceous plants the pollen-grains are united into masses, or *pollinia* (fig. 228), by means of viscid matter.

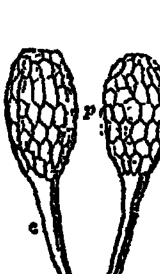


Fig. 228.

Fig. 229.

Fig. 230.

FIG. 228.—Pollinia, or pollen-masses, separated from the point above the stigma, with their retinacula or viscid matter attaching them at the base. The pollen masses *p* are supported on stalks or caudicles *c*. These masses are easily detached by the agency of insects.

FIG. 229.—Pistil of Asclepias, *a*, with pollen-masses, *p* adhering to the stigma *s*. *b*, pollen-masses, removed from the stigma, united by a gland-like body.

FIG. 230.—Stamen of Asclepias, showing filament *f*. anther *a*, and appendage *p*.

In Orchids each of the pollen-masses has a prolongation or stalk, called a *caudicle*, which adheres to a prolongation at the base of the anther, called *rostellum*, by means of a viscous gland, called *retinaculum*. The gland is either naked or covered. The term *clinandrium* is sometimes applied to the part of the column in Orchids where the

stamens are situated. In some Orchids, as Cypripedium, the pollen has its ordinary character of separate grains. The number of pollinia varies; thus, in Orchis there are usually two, in Cattleya four, and in Lælia eight. The two pollinia in Orchis Morio contain each about 200 secondary smaller masses. These small masses, when bruised, divide into grains which are united in fours. In Asclepiadaceæ the pollinia are usually united in pairs (fig. 229), belonging to two contiguous antherine cavities,—each pollen-mass having a caudicular appendage, ending in a common gland, by means of which they are attached to a process of the stigma. The pollinia are also provided with an appendicular staminal covering (fig. 230).

When mature, the pollen-grain is a cellular body having an external covering, *extine*, and an internal, *intine*. Fritzsche states that he has detected, in some cases, other two coverings, which he calls *intextine* and *exintine*. They occur between the extine and intine, and are probably formed by foldings of these membranes. In some aquatics, as Zostera marina, Zannichellia pedunculata, Naias minor, &c., only one covering exists, and that is said to be the intine. The extine is a firm membrane, which defines the figure of the pollen-grain, and gives colour to it. It is either smooth, or covered with numerous projections (fig. 231), granules, points, minute hairs, or crested reticulations. The colour is generally yellow, and the surface is often covered with a viscid or oily matter. The intine is uniform in different kinds of pollen, thin and transparent, and possesses great power of extension.

Pollen-grains vary from $\frac{1}{300}$ to $\frac{1}{100}$ of an inch or less in diameter. Their forms are various. The most common form of grain is ellipsoidal, more or less narrow at the extremities, which are called its *poles*, in contradistinction to a line equidistant from the extremities, and which is its equator. Pollen-grains are also spherical; cylindrical and curved, as in Tradescantia virginica; polyhedral in Dipsacaceæ and Compositæ; nearly triangular in Proteaceæ and Onagraceæ (fig. 232). The surface of the pollen-grain is either uniform and homogeneous, or it is marked by

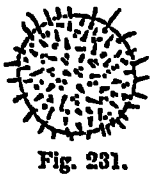


Fig. 231.

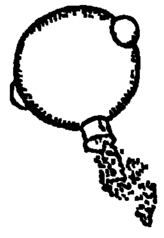


Fig. 233.

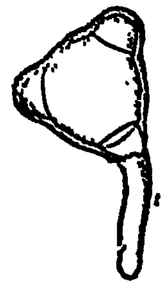


Fig. 232

Fig. 234.

FIG. 231.—Ripe round pollen of Hollyhock (*Althæa*), with its extine covered with prominent points.
FIG. 232.—Triangular pollen of Evening Primrose (*Œnothera*), with one pollen tube, *t*, protruded. This tube is formed by the intine, which is also seen projecting at the other angles.
FIG. 233.—Ripe rounded pollen of Cherry (*Cerasus*), discharging its fovilla through a tubular opening formed by the intine. There are other two points at which the intine is seen protruding.
FIG. 234.—Male flower of Pellitory (*Parietaria officinalis*), having four stamens with incurved elastic filaments, and an abortive pistil in the centre. When the perianth expands, the filaments are thrown out with force, so as to scatter the pollen on the female flowers in the vicinity.

folds dipping in towards the centre, and formed by thinnings of the membrane. In Monocotyledonous plants there is usually a single fold; in Dicotyledons, often three. Two, four, six, and even twelve folds are also met with. There are also rounded portions of the membrane or points of perforation or pores visible in the pollen-grain. These vary in number from one to fifty. In Monocotyledons, as in Grasses, there is often only one, while in Dicotyledons they number from three upwards. When numerous, these points are either scattered irregularly, or in a regular order, frequently forming a circle round the equatorial surface. Sometimes at the place where they exist, the outer membrane, in place of being thin and transparent, is separated in the form of a lid, thus becoming *operculate*, as in the Passion-flower and Gourd. Grains of pollen have sometimes both folds and pores. Within the pollen-grain a granular semifluid matter called *fovilla* is contained, along with some oily particles, and occasionally starch. The fovilla contains small spherical granules, sometimes the $\frac{1}{30000}$ of an inch in diameter, and large ellipsoidal or elongated corpuscles, which exhibit molecular movements under the microscope. The application of moisture affects very markedly the pollen-grain, causing it to swell up by endosmose. If the moisture be long applied the distension becomes so great as to rupture the extine irregularly if it is homogeneous, or to cause projections and final rupture at the folds or pores when they exist. The intine, from its distensibility, is not so liable to rupture; it is often forced through the ruptured extine, or through the pores, in the form of small sac-like projections. The internal membrane ultimately gives way, and allows the granular fovilla to escape (fig. 233). If the fluid is applied only to one side of the pollen-grain, as when the pollen is applied to the pistil, the distension goes on more slowly, and the intine is prolonged outwards like a hernia, and forms an elongated tube called a *pollen-tube* (fig. 232). This tube, at its base, is often covered by the ruptured extine, and it contains in its interior fovilla-granules. The number of pollen-tubes which may be produced depends on the number of pores. In some pollinia the number of tubes which are formed is enormous. Thus, it has been calculated that two pollen-masses of Orchis Morio may give out 120,000 tubes.

When the pollen-grains are ripe, the anther dehisces (figs. 175, 223), and the pollen is shed. In order that fertilization may be effected the pollen must be conveyed to the female organ of reproduction. This process, termed *pollination*, is promoted in various ways,—the whole form and structure of the flower having relation to the process. In some plants, as Kalmia and Pellitory (fig. 234), the mere elasticity of the filaments is sufficient to effect this; in other plants pollination is effected by the wind, as in Coniferæ, and in such cases enormous quantities of pollen are produced. These plants are *anemophilous*. But the common agents for pollination are insects. To allure and attract them to visit the flower the odoriferous secretions and gay colours are developed, and the position and complicated structure of the parts of the flower are adapted to the perfect performance of the process. It is rare in hermaphrodite flowers for self-fertilization to occur, and the various forms of dichogamy, dimorphism, and trimorphism are fitted to prevent this. Pollination.

Under the term *disk* is included every structure intervening between the stamens and the pistil. It was to such structures that the name of *nectary* was applied by old authors. It presents great varieties of form, such as a ring, scales, glands, hairs, petaloid appendages, &c., and in the progress of growth it often contains saccharine matter, thus becoming truly nectariferous. The disk is frequently formed by degeneration or transformation of the staminal row. It may consist of processes rising from the torus, alternating with the stamens, and thus representing an abortive whorl; or its parts may be oppo- Disk.

site to the stamens, as in Crassula rubens (fig. 172). In some flowers, as Jatropha Curcas, in which the stamens are not developed, their place is occupied by glandular bodies forming the disk. In Gesneraceæ and Cruciferæ the disk consists of tooth-like scales at the base of the stamens (fig. 227). The parts composing the disk sometimes unite and form a glandular ring, as in the Orange; or they form a dark-red lamina covering the pistil, as in Pæonia Moutan (fig. 235); or a waxy lining of the calyx tube or hollow receptacle, as in the Rose; or a swelling at the top of the ovary, as in Umbelliferæ, in which the disk is said to be epigynous. The enlarged torus covering the ovary in Nymphæa and Nelumbium may be regarded as a form of disk.

Plate VII.

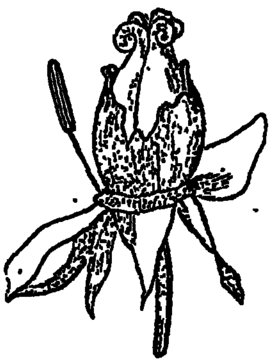


Fig. 235.

Flower of Tree Pæony (*Pæonia Moutan*), deprived of its corolla, and showing the disk in the form of a fleshy expansion covering the ovary.

2. *Male Organs in Cryptogams.*

Male organs. Cryptogams.

Sexual organs have not as yet been demonstrated in all Cryptogamic plants; but in most of them certain structures representing the male organs have been found. These are termed *Antheridia* or *Pollinodia* (figs. 236, 250). They are closed sacs of various forms,—rounded, ovate, oblong, clavate, flask-like, &c.,—developed from various parts of the plants, and composed either of one or of many cells enclosing a single central cell. In the interior of this organ small cells (fig. 236, *c*) are formed of varying shape, containing in their interior peculiar bodies, termed *antherozoids, spermatozoids*, or *phytozoa* (fig. 237). These are in most cases filamentous spirally coiled cells, frequently with *cilia*

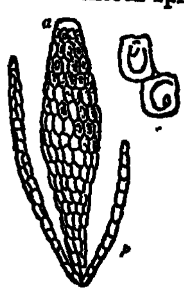


Fig. 236.

Fig. 237.

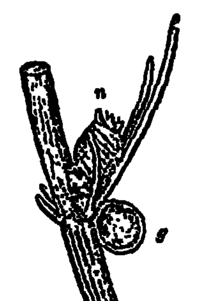


Fig. 240

Fig. 238.

Fig. 239.

Fig. 241.

Fig. 236.—Antheridium *a* of the Hair-moss (*Polytrichum*), consisting of cellules *c*, containing phytozoa coiled up in their interior. The phytozoa have a thickened extremity, whence proceeds a tapering tail-like process. Along with the antheridium are two separate filaments or paraphyses *p*, which are probably abortive antheridia.
Fig. 237.—A spermatozoid with cilia, discharged from a cellule in the antheridium of the Forked Spleenwort (*Asplenium septentrionale*).
Fig. 238.—Antheridium *a*, or zootheca, of a Sea-weed (*Fucus serratus*), containing phytozoa. With the antheridium there are paraphyses united in the same conceptacle.
Fig. 239.—Antheridium of a Sea-weed (*Fucus serratus*), still containing two phytozoa in the sac. To the broad part of the phytozoa two vibratile cilia are attached.
Fig. 240.—Axis of Chara, with branches from the axil of which arises the nucule *n*; below them is the globule *g*.
Fig. 241.—Globule of Chara, being a rounded body with eight radiating valves externally, and filaments containing phytozoary cells internally.

attached, by means of which they move rapidly through the water. In some cases there are no cilia, as in the Algal group of Florideæ; and the antherozoids of all Algæ differ from those of other Cryptogams in never being filamentous, but short and more or less rounded. The amount of twisting of the antherozoid varies; in some Rhizocarps there are as many as a dozen coils. Antheridia of this kind have been demonstrated in all vascular Cryptogams, but only in some Thallogens have such structures been seen.

In Characeæ, however, the antheridium, which is here termed *globule* (fig. 240), has a peculiar structure, differing from all other Cryptogams. It is a globular case, formed by eight flat cells, of which four are quadrangular and four are triangular; and these are folded at the margins so that the edges of contiguous plates dovetail (fig. 241). These are termed *shields*. Into the cavity of the globule the terminal cell of the stalk supporting it projects. From the centre of each shield projects on the inner surface a large oblong cell or *manubrium*, which in turn bears at its apex a roundish cell termed the *head*. From each head-cell six secondary head-cells project, from each of which pass off four slender separate filaments (fig. 242) containing antherozoids. When mature the antheridium is ruptured, and the mother-cells of the antherozoid escape and discharge the antherozoids into the surrounding medium which is always water—fertilization only being effected in water, by which the antherozoids are carried to the female organ. In some cases, however, among Thallogens the antheridium actually penetrates into the female organ.

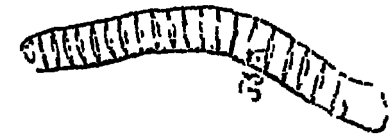


Fig. 242.

Partitioned filament of Chara, consisting of a series of cellules containing phytozoa, one of which is seen escaping in the form of a spiral thread.

Antheridia are produced on various parts of plants. Where they have been found amongst Thallogens, they arise from definite portions of the cellular thallus. In thalloid Hepaticæ they may be sunk in the substance of the thallus, or they may be imbedded in the upper surface of a peltate stalked disk rising from the thallus, as in Marchantia (figs. 243, 244). In Mosses they may be seated within the same whorl of leaves or perichætium as the female organs, or they may be separate and surrounded by a *perigone*; but they are always formed upon the leaf-bearing axis, either terminal or lateral. In Ferns and Equisetum they are produced on the surface—usually the lower surface—of a cellular flattened expansion, termed a *prothallus* (figs. 245, 250), in close proximity to the female organs. In Characeæ they always arise from the termination of one of the whorled leaflets.

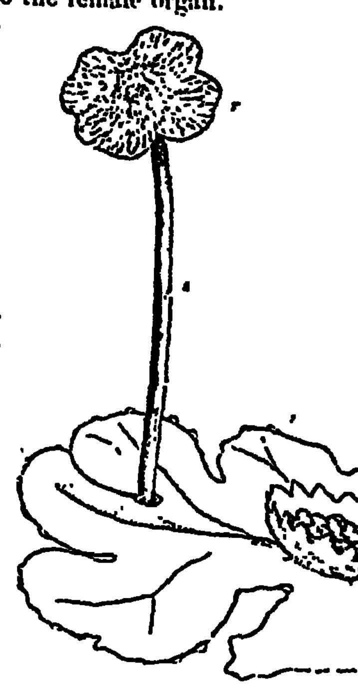


Fig. 243.

A species of Liverwort (*Marchantia polymorpha*) with its green thallus *t*, bearing a cup-like body *g*, in which minute cells or free buds are seen, and a stalked receptacle *s, r*. In the substance of the disk-like receptacle *r* cells are produced containing phytozoa. These are considered antheridia.

In some Lycopodiaceæ no antheridia have as yet been found; but in Selaginella, Isoetes, and in the Rhizocarpeæ, hollow sacs, termed *microsporangia* (figs. 246, 248), are produced in the axil of certain leaves of the

plant, in which small cells, *microspores* (fig. 249), are found, each consisting of an outer covering or *exospore*, and an inner or *endospore*. Within those microspores (the manner varying in different genera) smaller cells are formed, which are the mother-cells of the antherozoids. In this

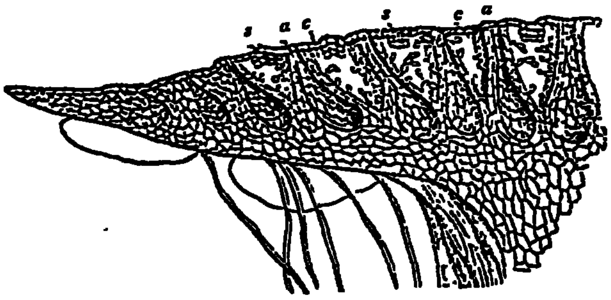


Fig. 244.

Vertical section of the disk-like receptacle of Liverwort (*Marchantia*), showing antheridia *a*, *a* in its substance. These antheridia are flask-shaped sacs containing phytozoary cells. They communicate with the upper surface, and their contents are discharged through it. Between the antheridia there are air cavities *c*, *c*, connected with stomata *s*, *s*.

development of Lycopodiaceæ we have parts which are analogous to those of the stamens in Phanerogams. The microsporangium evidently corresponds to the pollen-sac, and the microspores are the equivalents of the pollen-grains,—the forms seen in such Gymnosperms as Cycadaceæ being the link connecting them with the highest forms.

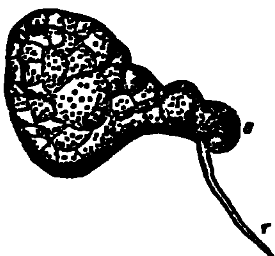
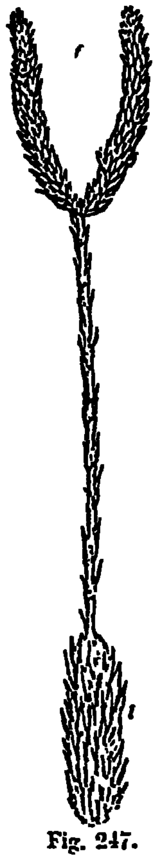


Fig. 245.



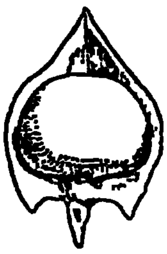


Fig. 246. Fig. 248.

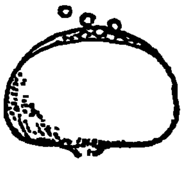


Fig. 249. Fig. 250. Fig. 247.

Fig. 245.—Spore *s*, of a Fern (*Pteris longifolia*) sprouting, giving off a root-like process, *r*, and a flat cellular expansion, *p*, called the prothallus or prothallium. On this expansion antheridia and pistillidia are said to occur.

Fig. 246.—Fructification of Club-Moss (*Lycopodium*), situated in the axil of a leaf, *l*. It consists of a case containing minute cellular bodies, which are discharged in the form of powder.

Fig. 247.—Fructification of a Club-Moss (*Lycopodium clavatum*) The branch is covered with minute pointed leaves, *l*; from it proceeds a stalk bearing at its extremity two spikes, *f*, consisting of modified leaves, with fructification.

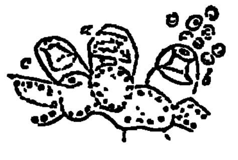
Fig. 248.—One of the cases separated from the axil of the Club-Moss leaf, opening by two valves, and discharging the minute Lycopod powder (microspores).

Fig. 249.—The small spore of a Rhizocarp (*Pilularia globulifera*, Pillwort). The inner coat is protruded, and the outer coat has burst so as to discharge cellules containing spermatozoids. Some of the spermatozoids are separate, and are seen coiled up in a spiral form.

Fig. 250.—Antheridia from the prothallus of the Common Brake (*Pteris aquilina*) *a*, an unopened antheridium; *b*, antheridium bursting at the apex, and discharging free cellules, each containing a spermatozoid; *c*, antheridium after the discharge of the cellules.

3. *Female Organs in Phanerogams.*

The pistil or *gynœcium* occupies the centre or axis of the flower, and is surrounded by the stamens and floral envelopes when these are present. It constitutes the innermost whorl, and is the female organ of the plant, which after The pistil.
flowering is changed into the fruit, and contains the seeds. It consists essentially of two parts, a basal portion forming a chamber, the *ovary* or *germen*, containing ovules or young seeds attached to a part called the *placenta*, and an upper portion, the *stigma*, a cellular secreting body, which is either seated on the ovary, and is then called *sessile*, as in the Tulip and Poppy, or is elevated on a stalk called the Plate I.
style, interposed between the ovary and stigma. The style



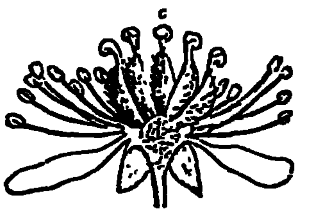


Fig. 251. Fig. 252. Fig. 253.

Fig. 251.—Folded carpellary leaf of the double-flowering Cherry. In place of fruit the plant produces leaves.

Fig. 252.—Vertical section of the flower of Meadow-sweet (*Spiræa*). The pistil is apocarpous, consisting of several distinct carpels *c*, each with ovary, style, and stigma. The stamens are indefinite, and are inserted into the calyx.

Fig. 253.—Pistil of Broom, consisting of ovary *o*, style *s*, and stigma *t*. It is formed by a single carpel. The terms pistil and carpel are here synonymous.

is not necessary for the perfection of the pistil. Like the Plate V.
other organs, the pistil consists of one or more modified leaves, which in this instance are called *carpels*. When a pistil consists of a single carpel it is *simple* or monocarpellary (fig. 253), a state usually depending on the non-development of other carpels. When it is composed of several carpels, more or less united, it is *compound* or polycarpellary. In the first-mentioned case the terms carpel and pistil are synonymous. Each carpel has its own ovary, style (when present), and stigma, and is formed by a folded leaf, the upper surface of which is turned inwards towards the axis, and the lower outwards, while from its margins are developed one or more buds called *ovules*. That this is the true nature of the pistil may be seen by examining the flower of the double-flowering Cherry. In it no fruit is produced, and the pistil consists of sessile leaves (fig. 251), the limb of each being green and folded, with a narrow prolongation upwards, as if from the midrib, and ending in a thickened portion. The ovary then represents the limb or lamina of the leaf, and is composed of cellular tissue with fibro-vascular bundles, and an epidermal covering. The cellular tissue, or parenchyma, often becomes much developed, as will be seen particularly when fleshy fruits are considered. The outer epidermis corresponds to the lower side of the leaf, exhibiting stomata, and sometimes hairs; the inner surface represents the upper side of the leaf, being usually very delicate and pale, and forming a layer called sometimes *epithelium*, which does not exhibit stomata. The vascular bundles correspond with the veins of the leaf, and consist of spiral, annular, and other vessels. In Cycas the carpels Plate XV.
are ordinary leaves, with ovules upon their margin.

A pistil is usually formed by more than one carpel. The carpels may be arranged like leaves, either at the same or nearly the same height in a verticil, or at different heights in a spiral cycle. When they remain separate and distinct, thus showing at once the composition of the pistil, as in Caltha, Ranunculus, Hellebore, and Spiræa (fig. 252), the term *apocarpous* is applied. Thus, in Crassula rubens (fig. 172) the pistil consists of five verticillate carpels *c*, alternating with the stamens *e*. In the Tulip-tree and Ranunculus (fig. 254) the separate carpels are numerous and are arranged in a spiral cycle upon an elongated axis or receptacle. In the Raspberry the carpels are on a conical

receptacle; in the Strawberry, on a swollen succulent one (fig. 154); and in the Rose (fig. 155), on a hollow one. When the fruit consists of several rows of carpels, the innermost have their margins directed to the centre, while the margins of the outer rows are arranged on the back of the inner ones. When the carpels are united, as in the Pear, Arbutus, and Chickweed, the pistil becomes *syncarpous*. The number of carpels in an apocarpous pistil, or the number of separate styles in a syncarpous one, is indicated in the following way:—

A flower with a simple pistil or 1 style	is Monogynous.
2 separate carpels or 2 separate styles	is Digynous.
3 carpels or 3 separate styles	is Trigynous.
4 carpels or 4 separate styles	is Tetragynous.
5 carpels or 5 separate styles	is Pentagynous.
6 carpels or 6 separate styles	is Hexagynous.
7 carpels or 7 separate styles	is Heptagynous.
8 carpels or 8 separate styles	is Octogynous.
9 carpels or 9 separate styles	is Enneagynous.
10 carpels or 10 separate styles	is Decagynous.
12 carpels or 12 separate styles	is Dodecagynous.
a greater number of carpels or styles	is Polygynous.

The union in a syncarpous pistil is not always complete; it may take place by the ovaries alone, while the styles and stigmata remain free, the pistil being then *gamogastrous* (fig. 255), and in this case, when the ovaries form apparently a single body, the organ receives the name of *compound* ovary; or the union may take place by the ovaries and styles, while the stigmata are *disunited*; or by the stigmata and the summit of the style only. Various intermediate states exist, such as *partial union* of the ovaries, as in the Rue, where they coalesce at their base; Plate III. and partial *union of the styles*, as in Malvaceæ. The union is usually most complete at the base; but in Labiatæ the styles are united throughout their length, and in Apocynaceæ and Asclepiadaceæ the stigmata only. When the union is incomplete, the number of the parts of a compound pistil may be determined by the number of styles and *stigmata*; when complete, the external venation, the grooves on the surface, and the internal divisions of the ovary, indicate the number. The changes which take place in the pistil by adhesion, degeneration, and abortion, are frequently so great as to obscure its composition, and to lead to anomalies.

Fig. 254.

Fig. 255.

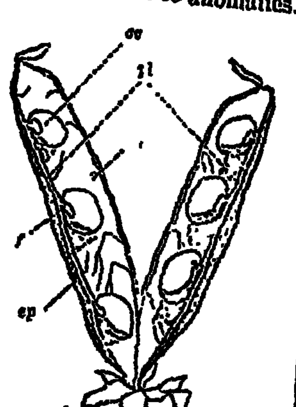


Fig. 256.

Fig. 254.—Apocarpous compound pistil of Crowfoot (*Ranunculus*), consisting of [illegible] separate uni-ovular carpels, arranged in spirals. Each carpel consists of ovary, *style*, and stigma. The flower is [illegible] to show their insertion below the pistil in the thalamus [illegible]. Two of the [illegible]

Fig. 255.—[illegible] pistil of Flax (*Linum*). It consists of five carpels, united [illegible] while their styles and stigmas are separate. Hence the flower [illegible]

Fig. 256.—[illegible] (*[illegible]*) laid open. It consists of a single [illegible] ov, which are attached to the placenta *pl*, by means of umbilical cords (funiculi) *f*. The [illegible] the outer, *ep*, corresponding to the upper epidermis [illegible] small amount of cellular tissue [illegible] is persistent. The style [illegible]

sessile leaves, but sometimes they are petiolate, and then are elevated above the external whorls. This elevation of the pistil may in general, however, be traced to an elongation of the axis itself, in such a way that the carpels, in place of being dispersed over it, arise only from its summit, and the pistil becomes *stipitate*, or supported on a stalk called a *gynophore* or *thecaphore*, as in the Passion-flower and Dictamnus (fig. 177). Sometimes the axis is produced beyond the ovaries, and the styles become united to it, as in Geraniaceæ (fig. 152) and Umbelliferæ. In this case the prolongation is called a *carpophore*. A Plate VII monstrosity often occurs in the Rose (fig. 145) by which the axis is prolonged, and bears the carpels *f* in the form of alternate leaves.

The ovary contains the ovules. These are attached to The the *placenta*. This, sometimes called the *trophosperm*, placenta. consists of a mass of cellular tissue, through which the vessels pass to the ovule. The placenta is usually formed on *the edges of the carpellary leaf (fig. 256), and is then said* to be of the *marginal* type. In many cases, however, the placentas are formations from the axis, and are not connected with the carpellary leaves; they are then said to be *axile*. Some restrict the term placenta to the point of attachment of a single ovule, and call the union of placentas, bearing several ovules, *placentaries* or *pistillary cords*. In marginal placentation the part of the carpel bearing the placenta is the *inner* or *ventral suture*, corresponding to the margin of the folded carpellary leaf, while the *outer* or *dorsal suture* corresponds to the midrib of the carpellary leaf. As the placenta is formed on each margin of the carpel it is essentially *double*. This is seen in cases where the margins of the carpel do not unite, but remain separate, and consequently two placentas are formed in place of one. When the pistil is formed by one carpel the inner margins unite in the axis, and form usually a common marginal placenta. This placenta may extend along the whole margin of the ovary as far as the base of the style (fig. 256), or it may be confined to the base or apex only. When the pistil is composed of several separate carpels, or, in other words, is apocarpous, there are generally separate placentas at each of their margins. In a syncarpous pistil, on the other hand, the carpels are so united that the edges of each of the contiguous ones, by their union, form a *septum*, or *dissepiment*, and the number of these septa consequently indicates the number of carpels in the compound pistil (fig. 257). It is obvious then that each dissepiment

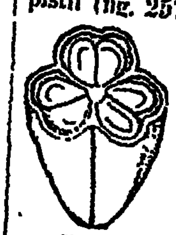


Fig. 257.

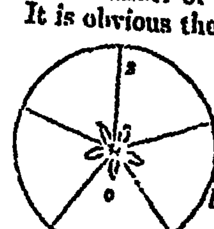


Fig. 258.

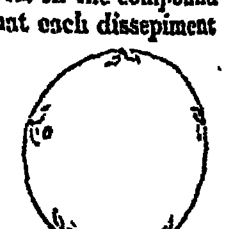


Fig. 259.

Fig. 257.—Ovary or lower part of the pistil of the Lily (*Lilium*), cut transversely. There are three loculaments, indicating the union of three carpels, and the ovary is said to be trilocular. The divisions in the ovary, called septa or dissepiments, are *formed* by the sides of the carpellary leaves. Each septum is double, and the number of septa corresponds with the number of the carpels. The ovules are placed collaterally, in pairs, in each loculament, and are attached to a central placenta, formed by the union of the three ventral sutures.

Fig. 258.—Diagrammatic section *of* a quinquelocular or pentathecal ovary, composed of five carpels, the edges of which are folded inwards, and meet in the centre. The ovules o are attached to a central placenta, formed by the union of the five ventral sutures. The five partitions, septa, or dissepiments, s, are composed of the *two sides of* contiguous carpels. Dorsal suture, *l*.

Fig. 259.—Diagrammatic section of a quinquelocular ovary, in which the edges of the carpels, bearing the placentas and ovules o, are not folded inwards. The placentas are parietal, and the ovules appear sessile on the walls of the ovary. The compound ovary is unilocular, and the edges of its carpels are applied to each other in a valvular manner.

is formed by a double wall or two laminæ; that the presence of a septum implies the presence of more than one carpel; and that, when carpels are placed side by side, true dissepiments must be vertical, and not horizontal. When the dissepiments extend to the centre or axis, the ovary is

divided into cavities, *cells*, or *loculaments*, and it may be *bilocular*, *trilocular* (fig. 257), *quadrilocular*, *quinqulocular*, or *multilocular*, according as it is formed by two, three, four, five, or many carpels, each carpel corresponding to a single cell or loculament. In these cases the marginal placentas meet in the axis, and unite so as to form a single *central* one (figs. 257, 258), and the ovules appear in the central angle of the loculi, as in Canna, Lily (fig. 257). The number of loculaments is equal to that of the dissepiments. When the carpels in a syncarpous pistil do not fold inwards completely so as to meet in the centre, but only partially, so that the dissepiments appear as projections on the walls of the ovary, then the ovary is *unilocular* (fig. 260), and the placentas are *parietal*, as in Viola (fig. 261). In

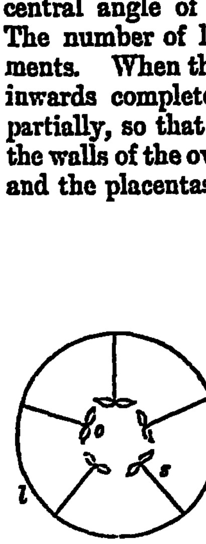


Fig. 260.

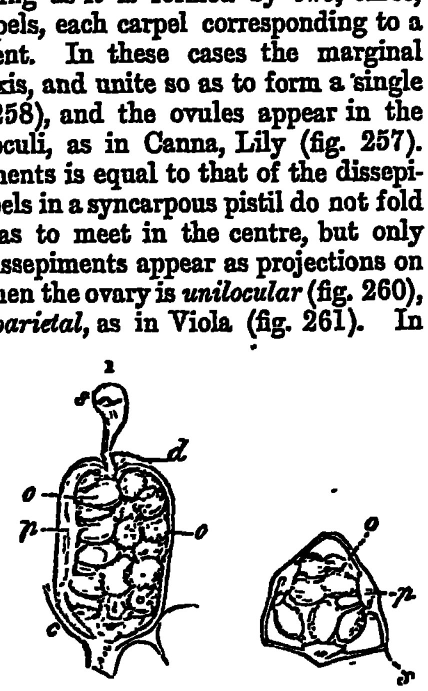


Fig. 261.

FIG. 260.—Diagrammatic section of a quinquelocular ovary, in which the septa *s* proceed inwards for a certain length, bearing the placentas and ovules *o*. In this case the ovary is unilocular, and the placentas are parietal. Dorsum, *l*.
FIG. 261.—Pistil of *Viola tricolor*, or Pansy. 1. Vertical section to show the ovules *o*, attached to the parietes. Two rows of ovules are seen, one in front, and the other in profile; *p*, a thickened line on the walls forming the placenta; *c*, calyx; *d*, ovary; *s*, hooded stigma terminating the short style. 2. Horizontal section of the same: *p*, placenta; *o*, ovules; *s*, suture.

these instances the placentas may be formed at the margin of the united contiguous leaves, so as to appear single, or the margins may not be united, each developing a placenta. Frequently the margins of the carpels, which fold in to the centre, split there into two lamellæ, each of which is curved outwards and projects into the loculament, dilating at the end into a placenta. This is well seen in Cucurbitaceæ (fig. 262), Pyrola, &c. From this it will be seen that dissepiments are opposite to placentas formed by the union of the margins of two contiguous carpels, but alternate with those formed by the margins of the same carpel. The carpellary leaves may fold inwards very slightly, or they may be applied in a valvate manner, merely touching at their margins, the placentas then being parietal (fig. 259), and appearing as lines or thickenings

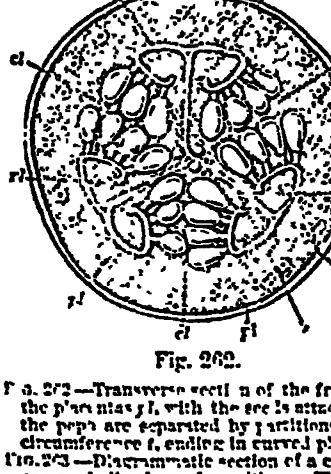


Fig. 262.

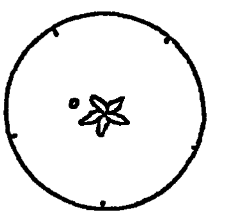


Fig. 263.

FIG. 262.—Transverse section of the fruit of the Melon (*Cucumis Melo*), showing the placentas *pl*, with the ovules attached to them. The three carpels forming the pepo are separated by partitions *cl*. From the centre, processes *s*, go to circumference *f*, ending in curved placentaries bearing the ovules.
FIG. 263.—Diagrammatic section of a compound unilocular ovary, in which there are no indications of partitions. The ovules *o* are attached to a free central placenta, which has no connection with the walls of the ovary.

along the walls. Cases occur, however, in which the placentas are not connected with the walls of the ovary, and form what is called a *free central placenta* (fig. 263). This is seen in many of the Caryophyllaceæ and Primulaceæ (figs. 264, 265). In Caryophyllaceæ, however, while the placenta is free in the centre, there are often traces found at the base of the ovary of the remains of septa, as if rupture had taken place, and, in rare instances, ovules are found on the margins of the carpels. But in Primulaceæ, Myrsinaceæ, and Santalaceæ, no vestiges of septa or marginal ovules can be perceived at any period of growth; the placenta is always free, and rises in the centre of the ovary, and the part uncovered by ovules gradually extends into the style. Free central placentation, therefore, has been accounted for in two ways; either by supposing that the placentas in the early state were formed on the margins of carpellary leaves, and that in the progress of development these leaves separated from them, leaving the placentas and ovules free in the centre; or by supposing that the placentas are not *marginal* but *axile* formations, produced by an elongation of the axis, the ovules being lateral buds, and the carpels verticillate leaves, united together around the axis. The first of these views would apply well to Caryophyllaceæ, the second to Primulaceæ. The latter case has also been explained, on the marginal hypothesis, by considering the placentas as formed from the carpels by a process of chorisis, and united together in the centre.

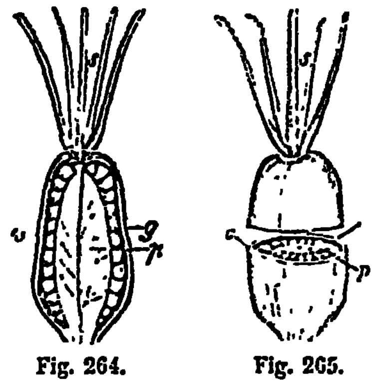


Fig. 264. Fig. 265.

FIG. 264.—Pistil of *Cerastium hirsutum* cut vertically. *o*, unilocular or monothecal ovary; *p*, free central placenta; *g*, ovules; *s*, styles.
FIG. 265.—The same cut horizontally, and the halves separated so as to show the interior of the cavity of the ovary *o*, with the free central placenta *p*, covered with ovules *g*.

Some consider the axile view of placentation as applicable to all cases, the axis in some instances remaining free and independent, at other times sending prolongations along the margins of the carpellary leaves, and thus forming the marginal placentas. Occasionally, divisions take place in ovaries which are not formed by the edges of contiguous carpels. These are called *spurious dissepiments*. They are often horizontal, and are then called *phragmata*, as in Cathartocarpus Fistula, where they consist of transverse cellular prolongations from the walls of the ovary, only developed after fertilization, and therefore more properly noticed under fruit. At other times they are vertical, as in Datura, where the ovary, in place of being two-celled, becomes four-celled; in Cruciferæ, where the prolongation of the placentas forms a *replum* or partition; in Astragalus and Thespesia, where the dorsal suture is folded inwards: in Oxytropis, where the ventral suture is folded inwards; and in Diplophractum, where the inner margin of the carpels is inflexed. In Cucurbitaceæ divisions are formed in the ovary apparently by peculiar projections inwards from curved parietal placentas. In some cases horizontal dissepiments are supposed to be formed by the union of carpels situated at different heights, so that the base of one becomes united to the apex of another. In such cases the divisions are true dissepiments formed by carpellary leaves. The anomalous divisions in the ovary of the Pomegranate have been thus explained.

The ovary is usually of a more or less spherical or curved form, sometimes smooth and uniform on its surface, at other times hairy and grooved. The grooves usually indicate the divisions between the carpels, and correspond to the dissepiments. The dorsal suture may be marked by a slight projection, or by a superficial groove. When the ovary is situated on the centre of the receptacle, free from the other whorls, so that its base is above the insertion of the stamens, it is

termed *superior*, as in Lychnis, Primula, and Geranium (fig. 215). When the margin of the receptacle is prolonged upwards, carrying with it the floral envelopes and staminal leaves, the basal portion of the ovary being formed by the receptacle, and the carpellary leaves alone closing in the apex, the ovary is *inferior*, as in Pomegranate, Apple, Pear, Gooseberry, and Fuchsia. In some plants, as many Saxifragaceæ, there are intermediate forms, in which the term *half-inferior* is applied to the ovary, whilst the floral whorls are *half-superior*.

The style. The *style* proceeds from the summit of the carpel, and may be looked upon as a prolongation of it in an upward direction (fig. 267). It is hence called *apicilar*. It consists not merely of the midrib but of the vascular and cellular tissue of the carpel, and when carefully examined is found to be traversed by a narrow canal, in which there are some loose projecting cells, a continuation of the placenta, constituting what is called conducting tissue, which ends in the stigma. This is particularly abundant when the pistil is ready for fertilization. In some cases, owing to more rapid growth of the dorsal side of the ovary, the style becomes *lateral* (fig. 266); this may so increase that the style appears to arise from near the base, as in the Strawberry, or from the base, as in Chrysobalanus Icaco, when it is called *basilar*. In all these cases the style still indicates the organic apex of the ovary, although it may not be the apparent apex. When in a compound pistil the style of each carpel is thus displaced, it appears as if the ovary were depressed in the centre, and the style rising from the depression in the midst of the carpels seems to come from the torus. Such a style is *gynobasic*, and is well seen in Boraginaceæ and Ochnaceæ. The form of the style is usually cylindrical, more or less filiform and simple; sometimes it is grooved on one side, at other times it is flat, thick, angular, compressed, and even petaloid, as in Iris and Canna. In Goodeniaceæ it ends in a cup-like expansion, enclosing the stigma. It may be smooth and covered with glands and hairs. These hairs occasionally aid in the application of the pollen to the stigma, and are called *collecting hairs*, as in Goldfussia, in Campanula, where they appear double and retractile, and also in Aster and other Compositæ. These hairs, during the upward development of the style, come into contact with the already

Fig. 266

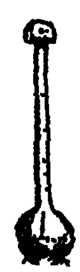


Fig. 267.

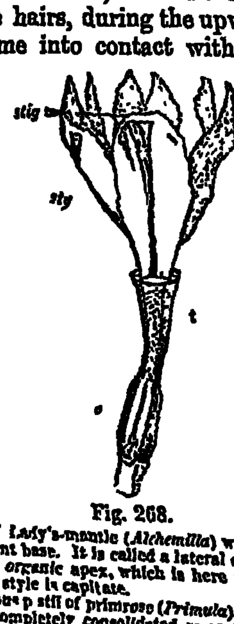


Fig. 268.

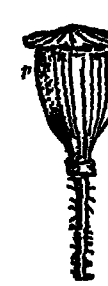


Fig. 269.

Fig. 266.—Uni-ovular carpel of Lady's-mantle (*Alchemilla*) with the style *s* arising laterally near the apparent base. It is called a lateral or semi-basilar style, although it arises from the *organic* apex, which is here turned round. The stigma at the summit of the style is capitate.
Fig. 267.—Compound or syncarpous pistil of primrose (*Primula*). The five carpels of which it is composed are completely consolidated so as to appear one. The ovaries *o*, the styles *t*, and stigmata *s*, are united. The flower is called monogynous, although in reality there are five parts of the pistil.
Fig. 268.—Gynæcium of the Flower-de-Luce (*Iris*), consisting of an ovary *o* adherent to the perianth, and a style *sty*, which divides into three petaloid segments bearing stigmas *stig*. The ovary is inferior, the perianth superior.
Fig. 269.—Capsule of Poppy, opening by pores *p*, under the radiating peltate stigma.

ripened pollen, and carry it up along with them, ready to be applied by insects to the mature stigma of other flowers. In Vicia and Lobelia the hairs frequently form a tuft below the stigma. The styles of a syncarpous pistil may be either separate or united; when separate, they alternate with the septa. When united completely, it is usual to call the style *simple* (fig. 267); when the union is partial, then the style is said to be *bifid*, *trifid*, *multifid*, according as it is two-cleft, three-cleft, many-cleft; or, to speak more correctly, according to the mode and extent of the union of two, three, or many styles. The style is said to be *bipartite*, *tripartite*, or *multipartite*, when the union of two, three, or many styles only extends a short way above the apex of the ovary. The style of a single carpel, or of each carpel of a compound pistil, may also be divided. Each division of the tricarpellary ovary of Jatropha Curcas has a *bifurcate* or forked style, and the ovary of Emblica officinalis has three styles, each of which is divided twice in a bifurcate manner, exhibiting thus a dichotomous division. The length of the style is determined by the relation which ought to subsist between the position of the stigma and that of the anthers, so as to allow the proper application of the pollen. In some cases the ovary passes insensibly into the style, as in Digitalis, in other instances there is a Plate XI marked transition from one to the other. The style may remain *persistent*, or it may fall off after fertilization is accomplished, and thus be *deciduous*.

The stigma. The *stigma* is the termination of the conducting tissue of the style, and is usually in direct communication with the placenta. It may, therefore, in most instances, be considered as the placental portion of the carpel, prolonged upwards. In Armeria, and some other plants, this connection with the placenta cannot be traced. The stigma consists of loose cellular tissue, and secretes a viscid matter which detains the pollen and causes it to protrude tubes. This secreting portion is, strictly speaking, the true stigma, but the name is generally applied to all the divisions of the style on which the stigmatic apparatus is situated. The stigma alternates with the dissepiments of a syncarpous pistil, or, in other words, corresponds with the back of the loculaments; but in some cases it would appear that half the stigma of one carpel unites with half that of the contiguous carpel, and thus the stigma is opposite the dissepiments, that is, alternates with the loculaments, as in the Poppy. If the stigma is viewed as essentially a prolongation of the placenta, then there is no necessary alternation between it and the placenta, both being formed by the margins of carpellary leaves, which in the one case are ovuliferous, in the other stigmatiferous. There is often a notch on one side of a stigma (as in some Rosaceæ), indicating apparently that it is a double organ like the placenta. To the division of a compound stigma the terms *bifid*, as in Labiatæ, Compositæ, *trifid*, as in Polemonium, &c., are applied, according to the number of the divisions. When the divisions are large, they are called *lobes*, and when flattened like bands, *lamellæ*; so that stigmas may be *bilobate*, *trilobate*, *bilamellar*, *trilamellar*, &c.

It has already been stated that the divisions of the stigma mark the number of carpels which are united together. A quinquefid or five-cleft stigma indicates five carpels, as in Campanula, although the other parts are united. In Bignoniaceæ, as well as in Scrophulariaceæ and Acanthaceæ, the two-lobed or bilamellar stigma indicates a bilocular ovary. Sometimes, however, as in the case of the styles, the stigma of a single carpel may divide. It is probable that in many instances what is called bifurcation of the style is only the division of the stigma. In Gramineæ and Compositæ there is a bifid stigma, and only one cavity in the ovary. This, however, may be probably traced to subsequent abortion in the ovary of one of the carpels. Its position may be terminal or lateral; either on one side of the style, *uni-*

lateral, as in Asimina, or on both sides, *bilateral*, as in Plantago. Occasionally, as in Tasmannia, it is prolonged along the inner surface of the style. In Iris it is situated on a cleft on the back of the petaloid divisions of the style (fig. 268). Some stigmata, as those of the Mimulus, present sensitive flattened laminæ, which close when touched. The stigma presents various forms. It may be globular, as in Mirabilis Jalapa; orbicular, as in Arbutus Andrachne; umbrella-like, as in Sarracenia, where, however, the proper stigmatic surface is beneath the angles of the large expansion of the apex of the style; ovoid, as in Fuchsia; hemispherical; polyhedral; radiating, as in
ı I. the Poppy (fig. 269), where the true stigmatic rays are attached to a sort of *peltate* or shield-like body, which may represent depressed or flattened styles; *cucullate*, *i.e.*, covered by a hood, in Calabar Bean, where it is situated on the apex of a declinate style, bearded (hairy) on its concave surface The lobes of a stigma may be flat and pointed, as in Mimulus and Bignonia, fleshy and blunt, smooth or granular, or they may be feathery, as in many Grasses (fig. 213). In Orchidaceæ the stigma is situated on the anterior surface of the column formed by the union of the styles and filaments,—the point where it occurs being called *gynizus*. In Asclepiadaceæ the stigmas are united to the face of the anthers, and along with them form a solid mass (fig. 229).

ıs- ıations istil. Transformations of the pistil are of frequent occurrence, and depend generally on abortion of a certain number of carpels, and on adhesions of various kinds. In the apocarpous pistils of Aconite, Nigella, Larkspur, and Pæony, we find on the same plant pistils composed of two, three, four, five, and six carpels. In some of the Brambles, all the carpels except one have been observed to disappear, thus making the fruit resemble that of the Plum. In the case of Leguminous plants there is usually only a single carpel, although the flower is pentamerous; this state has been traced to abortion of carpels, and the view is confirmed by finding plants in the same natural order with more than one carpel. Pistils of a succulent nature, such as those of the Sloe and Bird-cherry, sometimes assume the form of a pod, like that of the Pea. Occasionally stamens are changed into carpels, and at other times the carpels are transformed into stamens, and bear pollen.

ı ovule. The ovule is the body attached to the placenta, and destined to become the seed. Ovules are most usually produced on the margins of the carpellary leaves, but are also formed over the whole surface of the leaf, as in Cupressus. In other instances they rise from the floral axis itself, either as terminal buds, as in Polygonaceæ and Piperaceæ, or as lateral buds, as in Primulaceæ and Compositæ. The ovule is usually contained in an ovary, and all plants in which the ovule is so enclosed are termed *angiospermous;* but in Coniferæ and Cycadaceæ it is generally considered as having no proper ovarian covering, and is called *naked*, these orders being denominated *gymnospermous* The gymnospermal view is not adopted by all botanists. some maintaining that there is a true ovarian
ıto XV. covering In Cycas the altered leaf, upon the margin of which the ovule is produced, and the peltate scales, from which they are pendulous in Zamia, are regarded by all botanists as carpellary leaves But in the Coniferæ great discussion has arisen regarding the morphology of parts in many genera; some considering the scales at the base of the scaly bracts of the cone as a placental process growing from the bract. which is thus a carpellary leaf opened out and bearing a sessile ovule. the whole cone representing a single flower: while others. again. regard the scale as an ovular integument. and the ovule as being destitute of ovary. the outer scales being bracts. and the cone therefore being an inflorescence. The carpellary leaves are sometimes united in such a way as to leave an opening at the apex of the pistil, so that the ovules are exposed or *seminude*, as in Mignonette. In Leontice thalictroides (Blue Cohosh), species of Ophiopogon, Peliosanthes, and Stateria, the ovary ruptures immediately after flowering, and the ovules are exposed; and in species of Cuphea the placenta ultimately bursts through the ovary and corolla, and becomes erect, bearing the exposed ovules. The ovule is attached to the placenta either directly, when it is called *sessile*, or by means of a prolongation called a *funiculus*, *umbilical cord*, or *podosperm* (fig. 270*a*, *f*). This cord sometimes becomes much elongated after fertilization. The part by which the ovule is attached to the placenta or cord is its *base* or *hilum*, the opposite extremity being its *apex*. The latter is frequently turned round in such a way as to approach the base. The ovule is sometimes embedded in the placenta, as in Hydnora.


Fig. 270.

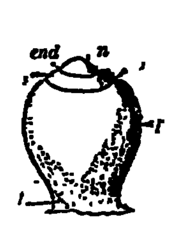


Fig. 270*a*.

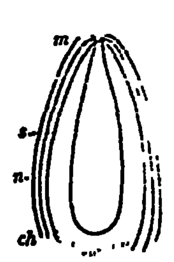


Fig. 271.

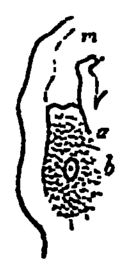


Fig. 272.

FIG. 270.—Young ovule of Celandine (*Chelidonium majus*) before its coverings are developed. It consists of the nucleus *n*, which at this stage of growth is naked. The base of the nucleus, where the nourishing vessels enter, is marked *ch*. This point is called the chalaza.

FIG. 270*a*.—The ovule of Polygonum, with its nucleus *n*, covered by the inner coat *s*, or the secundine, and the outer coat *p*, or the primine. The opening in the secundine, *end*, is called the endostome, that in the primine, *ex*, is the exostome. The point of the nucleus is seen projecting at the foramen. The end by which the ovule is attached to the placenta is marked *f*.

FIG. 271.—Orthotropous or orthotropal ovule of Polygonum, showing the embryo-sac *s*, in the nucleus *n*, the different ovular coverings, the base of the nucleus or chalaza *ch*, and the apex of the ovule with its foramen *m*.

FIG. 272.—Vertical section of the ovule of the Austrian Pine (*Pinus austriaca*), showing the nucleus *a*, consisting of delicate cellular tissue containing deep in its substance an embryo-sac *b*, formed before impregnation by the coalescence of a vertical series of a few cells. The micropyle *m* is very wide, and through it the pollen-grains come into contact with the summit of the nucleus, into the substance of which they send their tubes.

The ovule appears at first as a small cellular projection from the placenta. The cells multiply until they assume a more or less enlarged ovate form, constituting what has been called the *nucleus* (fig. 270, *n*), or central cellular mass of the ovule. The nucleus may remain naked, and alone form the ovule, as in Balanophoraceæ, Santalaceæ, &c.; but in most plants it becomes surrounded by certain coverings or integuments during its development. These appear first in the form of cellular rings at the base of the nucleus, which gradually spread over its surface. In some cases only one covering is formed, especially amongst gamopetalous Dicotyledons, as in Compositæ, Campanulaceæ, also in Walnut, &c. But usually besides the single covering (fig. 270*a*, *s*) another is developed subsequently (fig. 270*a*, *p*), which gradually extends over that first formed, and ultimately covers it completely, except at the apex. There are thus two integuments to the nucleus, an

of the micropyle depends on the development of the nucleus, as well as on the thickness of the integuments. Where the integument is very thick and the nucleus small, the micropyle is a long canal, as in Hippuris; but more usually the nucleus is large, and the integuments reduced to a few layers of cells, and in this case the micropyle is correspondingly reduced. The nucleus alters in the progress of growth so as to be prepared for the development of the embryo in its interior. A single cell of the nucleus near its centre enlarges greatly until it forms a hollow cavity surrounded by the smaller cells of the nucleus. This cavity is the *embryo-sac* (fig. 274, *s*), and the protoplasmic contents have been termed the *amnios*. This embryo-sac increases in size, gradually supplanting the surrounding cellular tissue of the nucleus until it remains surrounded only by a thin layer of it; or it may actually extend at the apex beyond it, as in Phaseolus and Alsine media; or it may pass into the micropyle, as in Santalum. In Gymnosperms it usually remains deep in the nucleus and surrounded by a thick mass of cellular tissue (fig. 272). In Veronica, Euphrasia, and many Labiatæ, the neck of the embryo-sac becomes elongated and swollen, and from it are developed certain vermiform or filamentous appendages, which are probably connected with the nutrition of the embryo. In some cases more than one embryo-sac is formed. This occurs in some gymnospermous plants, as the Yew, and it is also seen in Cruciferæ. In the Mistleto several sacs are formed, but it is doubtful whether in this case several ovules have not coalesced. Usually only one becomes fully developed. When the embryo-sac has reached a certain stage of growth, a development of cellular tissue takes place within it by free cell formation. This occurs in all gymnospermous plants, and constitutes what is known as the *endosperm* (fig. 280, *b*). In angiospermous plants the endosperm is not formed until after fertilization, and it is rare to find any special development of cellular tissue within the embryo-sac before fertilization. But in some cases at the base of the embryo-sac a few cells are formed, which have been termed *antipodal cells*, and are frequently afterwards absorbed, or may be incorporated in the true endosperm when it is formed. The further processes of growth in gymnospermous ovules on the one hand, and angiospermous ovules on the other, differ so much that they must be noted separately.

At the apex of the embryo-sac in gymnosperms, two or more cells of the endosperm enlarge so as to form what have been termed *corpuscles* (fig. 273). Each of these divides so as to form a large lower terminal or *central cell*, and an

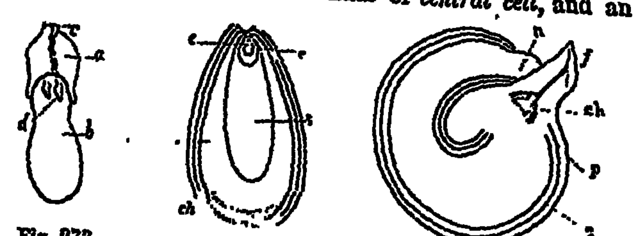


Fig. 273. Fig. 274. Fig. 275.

Fig. 273.—Vertical section of the embryo-sac *b*, and of part of the nucleus *a*, of
the ovule of the Weymouth Pine (*Pinus Strobus*). At the micropylar end of
the embryo-sac two cells, called corpuscles, *d*, have made their appearance.
Each of these is at first separated from the inner surface of the micropylar end
of the sac by a single cell, which afterwards divides into four, leaving a passage from the surface of the sac down to the corpuscle. The pollen-grain *c*,
on the summit of the nucleus, then sends down a tube which perforates the
embryo-sac, and reaches the corpuscle through the intercellular canal.
Fig. 274.—Diagram of ovule of Polygonum, showing the nucleus *n*, and the
embryo-sac *s*, containing a vesicle or germinal cell *c*, formed before impregnation. This cell, after fertilization, develops the first cell *e* of the embryo.
The dark shading at the base marks the chalaza, and the outer lines are the
integument, the micropyle being opposite the chalaza.
Fig. 275.—Campylotropous or campylotropal ovule of Wallflower (*Cheiranthus*),
showing the funiculus *f*, which attaches the ovule to the placenta; *p*, the
primine, *s*, the secundine, *n*, the nucleus, *ch*, the chalaza. The ovule is curved
upon itself, so that the foramen is near the funiculus.

upper *neck* of smaller cells (*stigmatic cells*), appearing as four when viewed from above, enclosing a *canal*. From the upper part of the central cell at the bottom of the neck, a small portion is separated—the *canal cell*. It is from a portion of the central cell that, after fertilization, the embryo is formed. Those parts all have great physiological importance in connection with fertilization. In angiosperms from the protoplasmic mass at the apex of the embryo-sac by free cell formation two (rarely one) elongated ovoid cells are produced. These are the *germinal vesicles* (fig. 274). In some angiosperms as Crocus, Maize, &c., the vesicles placed side by side are both equally elongated; to a considerable extent their lower ends are rounded, and there it is that the nucleus is found. The upper end projects into the micropyle, and is marked by distinct striæ longitudinally. This portion has been distinguished as the *filiform apparatus*. From the germinal vesicles after impregnation the embryo is formed, only one vesicle developing. This filiform apparatus is considered as corresponding to the canal cell formed from the corpuscula in gymnosperms, and it seems to serve for conducting the impregnating influence to the lower part of the central cell. In most angiosperms the germinal vesicles are placed obliquely over each other—one attached to the apex of the sac, the other lower down, and there is no filiform apparatus. Of these two vesicles the lower one alone forms an embryo, the upper one performing the same function as the filiform apparatus of other angiosperms, and the canal cell of gymnosperms. The point where the integuments are united to the base of the nucleus is called the *chalaza* (fig. 278, *ch*). This is often coloured, is of a denser texture than the surrounding tissue, and is traversed by fibro-vascular bundles, which pass from the placenta to nourish the ovule.

When the ovule is so developed that the point of union between the integuments and nucleus (the chalaza) is at the hilum (next the placenta), and the micropyle is at the opposite extremity, there being a short funiculus, the ovule is *orthotropal*, *orthotropous*, or *atropous*. This form is well seen in Polygonaceæ (fig. 271), Cistaceæ, and most gymnosperms. In such an ovule a straight line drawn from the hilum to the micropyle passes along the axis of the ovule. Where, by more rapid growth on one side than on the other, the nucleus, together with the integuments, is curved upon itself, so that the micropyle approaches the hilum, and ultimately is placed close to it, while the chalaza is at the hilum, the ovule is *campylotropal* or *campylotropous* (fig. 275) when the portions on the two sides of the line bisecting the angle of curvature are unequal, or *camptotropal* when they are equal. Curved ovules are found in Leguminosæ, Cruciferæ, and Caryophyllaceæ. Usually the opposite faces of the concavity of curvature of such ovules coalesce, and outwardly no indication of curvature is visible; but in some cases there is no coalition, and the ovule is *lecotropal*, or

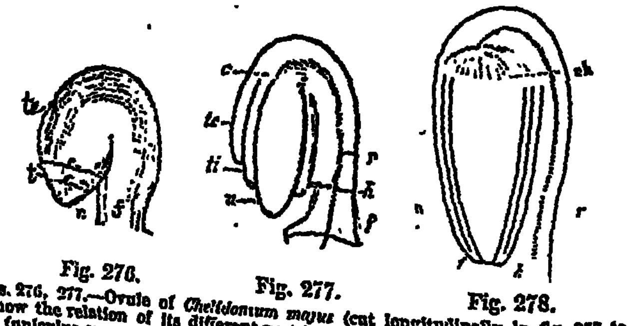


Fig. 276. Fig. 277. Fig. 278.

Figs. 276, 277.—Ovule of *Chelidonium majus* (cut longitudinally in fig. 277 to
show the relation of its different parts). *h*, hilum or umbilicus; *c*, chalaza,
f, funiculus or umbilical cord; *r*, raphe; *n*, nucleus; *ti*, secundine; *te*, primine;
ed, endostome; *ex*, exostome.
Fig. 278.—Anatropous or anatropal ovule of Dandelion (*Leontodon Taraxacum*),
showing the coats of the ovule surrounding the nucleus *n*, which is inverted,
so that its base *ch*, where the chalaza exists, is removed from the base or hilum
of the ovule *h*, while the foramen *f* is near the base. The connection between the
base of the ovule and the base of the nucleus at *s* is kept up by means of the raphe *r*.

horse-shoe shaped. The inverted, *anatropal*, or *anatropous* ovule (figs. 276; 277, 278) is the commonest form amongst

angiosperms. In this ovule the apex with the micropyle is turned towards the point of attachment of the funiculus to the placenta, the chalaza being situated at the opposite extremity; and the funiculus, which runs along the side usually next the placenta, coalesces with the ovule and constitutes the *raphe* (*r*), which often forms a ridge. The anatropal ovule arises from the placenta as a straight or only slightly curved cellular process, and as it grows, gradually becomes inverted, curving from the point of origin of the integuments. As the first integument (secundine) grows round it, the amount of inversion increases, and the funiculus becomes adherent to the side of the nucleus. Then if a primine be formed it covers all the free part of the ovule, but does not form on the side to which the raphe is adherent. Some anatropal ovules, however, seem to be formed in a different manner, the nucleus arising as a lateral bud from the apex of the funiculus, as in some Compositæ. These may be taken as the three types of ovule in the vegetable kingdom; but there are various intermediate forms, such as *semi-anatropal*, *amphitropal*, and *heterotropal* (transverse) ovules, where the funiculus is only, as it were, partially attached along one side, becoming free in the middle.

The position of the ovule relative to the ovary varies. When there is a single ovule, with its axis vertical, it may be attached to the placenta at the base of the ovary (*basal placenta*), and it is then *erect*, as in Polygonaceæ and Compositæ; or it may be inserted a little above the base, on a parietal placenta, with its apex upwards, and then is *ascending*, as in Parietaria. It may hang from an apicilar placenta at the summit of the ovary, its apex being directed downwards, and is *inverted* or *pendulous*, as in Hippuris vulgaris; or from a parietal placenta near the summit, and then is *suspended*, as in Daphne Mezereum,
XIII. Polygalaceæ, and Euphorbiaceæ. Sometimes a long funiculus arises from a basal placenta, reaches the summit of the ovary, and there bending over suspends the ovule, as in Armeria (Sea-pink); at other times the hilum appears to be in the middle, and the ovule becomes *horizontal*, *peltate*, or *peritropous*. When there are two ovules in the same cell, they may be either *collateral*, that is, placed side by side (fig. 257), or the one may be erect and the other inverted, as in some species of Spiræa and Æsculus; or they may be placed one above another, each directed similarly, as is the case in ovaries containing a moderate or definite number of ovules. Thus, in the ovary of Leguminous plants (fig. 256), the ovules *o*, are attached to the extended marginal placenta, one above the other, forming usually two parallel rows corresponding to each margin of the carpel. When the ovules are *definite* (*i.e.*, are uniform, and can be counted), it is usual to find their attachment so constant as to afford good characters for classification. When the ovules are very numerous (*indefinite*), while at the same time the placenta is not much developed, their position exhibits great variation, some being directed upwards, others downwards, others transversely; and their form is altered by pressure into various polyhedral shapes. In such cases it frequently happens that some of the ovules are arrested in their development and become abortive.

The homology of the ovule is by no means the same in all plants. In such cases as Polygonum and Piperaceæ, it represents the termination of the floral axis, and therefore is of the nature of a caulome. Again, in such plants as Primulaceæ and Compositæ, it is produced laterally upon the axis, and therefore represents a leaf, the integuments representing the lamina, and the funiculus the petiole,—the nucleus being an outgrowth from them. In some instances of malformation a transformation into these parts actually takes place. In cases where they are produced on the margin of the carpellary leaves (the usual mode), the ovules represent lobes of a leaf, and in some cases of monstrosity, as in Delphinium elatum, they appear as lobes of the carpellary leaf, whilst in Cupressus they are evidently outgrowths of the leaf. Further, the ovules in Orchidaceæ must be considered as mere trichomes, as they have no fibro-vascular bundles, and are developed from superficial cells of the placenta.

When the pistil has reached a certain stage in growth it becomes ready for fertilization. Pollination having been effected, and the pollen-grain having reached the stigma in angiosperms, the summit of the nucleus in gymnosperms, it is detained there, and the viscid secretion from the glands of the stigma in the former case, and the moisture from the ovule in the latter, induce the protrusion of the intine as a pollen-tube through the pores or points of perforation of the grain, many or few tubes being formed according to the number of pores. The pollen-tube or tubes pass down the canal (fig. 279), through the conducting tissue of the style when present, and reach the interior of the ovary in angiosperms, and then pass to the micropyle of the ovule, one pollen-tube going to each ovule. Sometimes the micropyle lies close to the base of the style, and then the pollen-tube enters it at once, but frequently it has to pass

Fertilization.

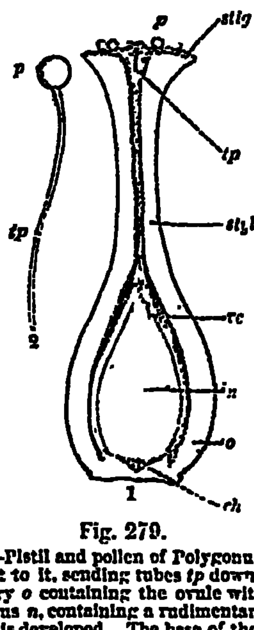


Fig. 279.

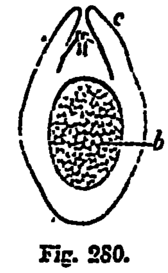


Fig. 280.

FIG. 279.—Pistil and pollen of Polygonum 1 Stigma, *stig*, with pollen-grains *p* adherent to it, sending tubes *tp* down the conducting tissue of the style *st l*; the ovary *o* containing the ovule with its covering and central cellular mass or nucleus *n*, containing a rudimentary embryo-sac *re*, in which ultimately the embryo is developed. The base of the ovule attached to the placenta is marked by the chalaza *ch*. 2. Pollen-grain *p*, separated, with pollen-tube *tp*.

FIG. 280.—Vertical section of the ovule of the Scotch Fir (*Pinus sylvestris*) in May of the second year, showing the enlarged embryo-sac *b*, full of endospermal cells, and pollen-tubes *c*, penetrating the summit of the nucleus after the pollen has entered the large micropyle of the ovule.

some distance into the ovary, being guided in its direction by various contrivances, as hairs, grooves, &c. In gymnosperms the pollen-grain resting on the apex of the nucleus sends out its pollen-tubes, which at once penetrate the nucleus of the ovule (fig. 280). In angiosperms when

the fruit, frequently incorporated with which are other parts of the flower, as receptacle, calyx, &c. In gymnosperms the pollen-tubes, having penetrated a certain distance down the tissue of the nucleus, are usually arrested in growth for a longer or shorter period, sometimes nearly a year. Subsequently growth recommences; the tube advances to the apex of the embryo-sac, which it pierces, and reaches the mouth of the canal of the corpuscle. It either descends the canal or remains attached at the mouth. The fovilla is transmitted to the central cell, and fertilization is complete, the central cell giving rise to the embryo. In angiosperms usually only one embryonal vesicle is fertilized, and one embryo is produced—*monoembryony*; but in some plants where many embryonal vesicles are formed, as in Citrus and Scabiosa, several of them may be fertilized, and thus many embryos produced—*polyembryony*. Usually, however, only one develops, so as to be capable of germination or growth. In gymnosperms it is very common to have polyembryony, although produced in a different way, for each central cell of a corpuscle may produce four embryos, and as the central cell of more than one corpuscle may be fertilized a great many embryos may be formed. They do not, however, all come to maturity.

4. *Female Organs of Phanerogams after Fertilization.*

a.—The Fruit.

Fruit After fertilization various changes take place in the parts of the flower. Those more immediately concerned in the process, the anther and stigma, rapidly wither and decay, while the filaments and style often remain for some time; the floral envelopes become dry, the petals fall, and the sepals are either deciduous, or remain persistent in an altered form; the ovary becomes enlarged, forming the *pericarp*; and the ovules are developed as the *seeds*, containing the *embryo-plant*. The term *fruit* is strictly applied to the mature pistil or ovary, with the seeds in its interior. But it often includes other parts of the flower, such as the bracts and floral envelopes. Thus the fruit of the Hazel and Oak consists of the ovary and bracts and calyx combined; that of the Apple, Pear, and Gooseberry, of the ovary and calyx; and that of the Pine-apple, of the ovaries and floral envelopes of several flowers combined. Such fruits are by some distinguished as *pseudocarps*. In popular language, the fruit includes all those parts which exhibit a striking change as the result of fertilization. In general, the fruit is not ripened unless fertilization has been effected; but cases occur in which the fruit swells, and becomes to all appearance perfect, while no seeds are produced. Thus, there are seedless Oranges, Grapes, and Pine-Apples. When the ovules are unfertilized, it is common to find that the ovary withers and does not come to maturity; but in the case of Bananas, Plantains, and Bread-fruit, the non-development of seeds seems to lead to a larger growth, and a greater succulence of fruit.

The fruit, like the ovary, may be formed of a single carpel, or of several. It may have one cell or cavity, being *unilocular*; or many, *multilocular*, &c. The number and nature of the divisions depend on the number of carpels, and the extent to which their edges are folded inwards. The appearances presented by the ovary do not always remain permanent in the fruit. Great changes are observed to take place, not merely as regards the increased size of the ovary, its softening and hardening, but also in its internal structure, owing to the suppression, additional formation, or enlargement of parts. Thus, in the Ash (fig. 281) an ovary with two cells, each containing an ovule attached to a central placenta, is changed into a unilocular fruit with one seed; one ovule, *l*, becoming abortive, while the other, *g*, gradually enlarging until the septum is pushed to one side, unites with the walls of the cell, and the placenta appears to be parietal. In the Oak and Hazel, an ovary with three cells, and two ovules in each, changes into a one-celled fruit with one seed. In the Coco-nut, a trilocular and triovular ovary is changed into a one-celled, one-seeded fruit. This abortion may depend on the pressure caused by the development of certain ovules, or it may proceed from non-fertilization of all the ovules and consequent non-enlargement of the carpels. Again, by the growth of the placenta, or the folding inwards of parts of the carpels, divisions occur in the fruit which did not exist in the ovary. In Pretrea zanzibarica, a one-celled ovary is changed into a four-celled fruit by the extension of the placenta. In Cathartocarpus Fistula a one celled ovary is changed into a fruit, having each of its seeds in a separate cell, in consequence of spurious dissepiments (*phragmata*) being produced in a horizontal manner, from the inner wall of the ovary. In Linum, by the folding inwards of the

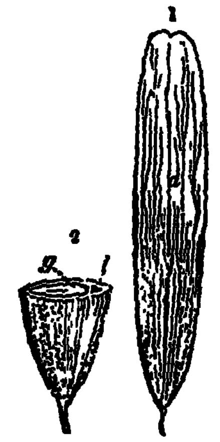


Fig. 281.

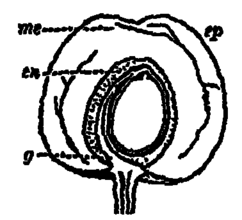


Fig. 282.

FIG. 281.—Samara or Samaroid fruit of *Fraxinus oxyphylla*. 1 Entire, with its wing *a*. 2. Lower portion cut transversely, to show that it consists of two loculaments; one of which, *l*, is abortive, and is reduced to a very small cavity, while the other is much enlarged, and filled with a seed *g*.
FIG. 282.—Drupe of the Cherry (*Cerasus*), cut vertically, showing the skin, or epicarp *ep*, the flesh or mesocarp *me*, and the stone, putamen, or endocarp *en*, enclosing the seed *g*, with the embryo.

back of the carpels a five-celled ovary becomes a ten-celled fruit. In Astragalus, the folding inwards of the dorsal suture converts a one-celled ovary into a two-celled fruit; and in Oxytropis the folding of the ventral suture gives rise to a similar change in the fruit. The development of cellular or pulpy matter, and the enlargement of parts not forming whorls of the flower, frequently alter the appearance of the fruit, and render it difficult to discover its formation. In the Gooseberry, Grape, Guava, Tomato, and Pomegranate, the seeds nestle in pulp, formed apparently by the placentas. In the Orange, the pulpy matter surrounding the seeds is formed by succulent cells, which are produced from the inner partitioned lining of the pericarp. In the Strawberry the receptacle becomes succulent, and bears the carpels on its convex surface (fig. 154); in the Rose there is a fleshy hollow torus or disk, which bears the carpels on its concave surface (fig. 155). In the Juniper the scaly bracts grow up round the seeds and become succulent, and in the Fig (fig. 150) the receptacle becomes succulent and encloses an inflorescence.

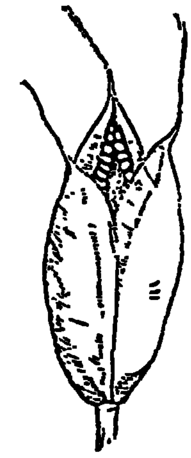
The pistil, in its simplest state, consists of a carpel or folded leaf, with ovules at its margin; and the same structure will be found in the fruit, where the pericarp represents the carpellary leaf, and the seeds correspond to the ovules. The pericarp consists usually of three layers, the external, or *epicarp* (fig. 282, *ep*), corresponding to the lower epidermis of the leaf; the middle, or *mesocarp*, *me*, representing the parenchyma of the leaf; and the internal, or *endocarp*, *en*, equivalent to the upper epidermis of the leaf, or the epithelium of the ovary. These layers are well seen in such

a fruit as the Peach or Plum, where they are separable one from the other; in them the epicarp forms what is commonly called the skin; the mesocarp, much developed, forms the flesh or pulp, and hence has sometimes been called *sarcocarp;* while the endocarp, hardened by the production of woody cells, forms the *stone* or *putamen,* immediately covering the kernel of the seed. The pulpy matter found in the interior of fruits, such as the Gooseberry, Grape, and Cathartocarpus Fistula, is formed from the placentas, and must not be confounded with the sarcocarp. In some fruits, as in the Nut, the three layers become blended together, and are indistinguishable. In Bladder Senna (Colutea arborescens) the pericarp retains its leaf-like appearance, but in most cases it becomes altered both in consistence and in colour. Thus in the Date the epicarp is the outer brownish skin, the pulpy matter is the mesocarp or sarcocarp, and the thin papery-like lining is the endocarp covering the hard seed. In the Medlar the endocarp becomes of a stony hardness. In the Melon the epicarp and endocarp are very thin, while the mesocarp forms the bulk of the fruit, differing in texture and taste in its external and internal parts. The rind of the Orange consists of epicarp and mesocarp, while the endocarp forms partitions in the interior, filled with pulpy cells. The part of the pericarp attached to the peduncle is called its *base,* and the point where the style or stigma existed is the *apex.* This latter is not always the apparent apex, as in the case of the ovary; it may be lateral or even basilar. The style sometimes remains in a hardened form, rendering the fruit *apiculate;* at other times it falls off, leaving only traces of its existence. The presence of the style or stigma serves to distinguish certain single-seeded pericarps from seeds.

hiscence ruits. When the fruit is mature and the contained seeds ripe, the carpels usually give way either at the ventral or dorsal suture or at both, and so allow the seeds to escape. The fruit in this case is *dehiscent.* But some fruits are *indehiscent,* falling to the ground entire, and the seeds eventually reaching the soil by their decay. By *dehiscence* the pericarp becomes divided into different pieces, or *valves,* the fruit being *univalvular, bivalvular,* or *multivalvular,* &c., according as there are one, two, or many valves. The splitting may extend the whole length of the fruit, or it may be only partial, the valves forming teeth at the apex of the fruit, and the dehiscence being *apicilar,* as in Caryophyllaceæ (fig. 283). Sometimes the valves are detached only at certain points, and thus dehiscence takes
te I. 2. place by pores at the apex, as in Poppy (fig. 269), or at the base, as in Campanula. Indehiscent fruits are either dry, as the Nut, or fleshy, as the Cherry and Apple. They may be formed of one or several carpels. In the former case they usually contain only a single seed, which may become so incorporated with the pericarp as to appear to be naked. Such fruits are called *pseudospermous* or false-seeded, and are exemplified in the grain of Wheat. In such cases the presence of the style or stigma determines their true nature.

Dehiscent fruits, when composed of single carpels, may open by the ventral suture only, as in the Pæony, Hellebore, Aquilegia (fig. 300), and Caltha; by the dorsal suture only, as in Magnolias and some Proteaceæ, or by both together, as in the Pea (fig. 256) and Bean; in these cases the dehiscence is called *sutural.* When composed of several united carpels, two types of dehiscence may be recognized—a longitudinal type and a transverse type. In the longitudinal type the separation may take place by the dissepiments throughout their length, so that the fruit is resolved into its original carpels, and each valve will be a carpel, as in Rhododendron, Colchicum, &c. This dehiscence, in consequence of taking place through the lamellæ of the septum, is called *septicidal* (figs. 284, 285). The valves may separate from their commissure, or central line of union, carrying the placentas with them, or they may leave the latter in the centre, so as to form with the

Fig. 283.



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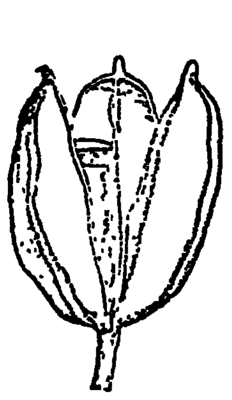

Fig. 286.

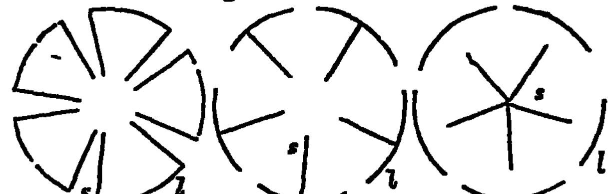

Fig. 285. Fig. 287. Fig. 288.

FIG. 283.—Seed-vessel or capsule of Campion (*Lychnis*), opening by ten teeth at the apex. The placenta is free central. The calyx is seen surrounding the seed-vessel, but not adherent.
FIG. 284.—Fruit or capsule of Meadow Saffron (*Colchicum autumnale*), dehiscing by three valves in a septicidal manner. The fruit is thus resolved into its three component carpels, with their styles and stigmas.
FIG. 285.—Diagram to illustrate the septicidal dehiscence in a pentalocular capsule. The loculaments *l* correspond to the number of the carpels, which separate by splitting through the septa *s*.
FIG. 286.—The seed vessel (capsule) of the Flower-de-Luce (*Iris*), opening in a loculicidal manner. The three valves bear the septa in the centre, and the opening takes place through the back of the loculaments. Each valve is formed by the halves of contiguous carpels.
FIG. 287.—Diagram to illustrate loculicidal dehiscence. The loculaments *l*, split at the back, and the valves separate, bearing the septa *s* on their centres.
FIG. 288.—Diagram to illustrate septifragal dehiscence, in which the dehiscence takes place through the back of the loculaments *l*, and the valves separate from the septa *s*, which are left attached to the placentas in the centre.

axis a column of a cylindrical, conical, or prismatic shape, which is termed the *columella.* The union between the edges of the carpels may be persistent, and they may dehisce by the dorsal suture, or through the back of the loculaments, as in the Lily and Iris (figs. 286, 287). In these cases each valve consists of a half of each of two contiguous carpels. The placentas either remain united to the axis, or they separate from it, being attached to the septa on the valves. This dehiscence is *loculicidal.* When the outer walls of the carpels break off from the septa, leaving them attached to the columella, the dehiscence is said to be *septifragal* (fig. 288), and where, as in Linum catharticum and Calluna, the splitting takes place first of all in a septicidal manner, the fruit is described as *septicidally septifragal;* while in other cases, as in Thorn Apple (Datura Stramonium), where the splitting is at first loculicidal, the dehiscence is *loculicidally septifragal.* In all those forms the separation of the valves takes place either from above downwards or from below upwards. But when the splitting only extends for a short distance, then dehiscence takes

dehiscence. In Saxifraga a splitting for a short distance of the ventral sutures of the carpels takes place, so that a single large apical pore is formed. In Caryophyllaceæ (fig. 283) numerous small valvular splittings occur, forming teeth at the apex, and a single apical orifice is formed. In the fruit of Cruciferæ, as Wallflower, there is a form of longitudinal dehiscence (fig. 289) in which the valves separate from the base of the fruit, leaving a central *replum*, or frame, which is a phragma formed by a prolongation from the parietal placentas on opposite sides of the fruit, extending between the ventral sutures of the carpels. In Orchidaceæ (fig. 290) the pericarp, when ripe, separates into three valves, in a loculicidal manner, but the midribs of the carpels, to which the placentas are attached, remain adherent to the axis both at the apex and base, and form three arches, bearing the seeds, after the valves have fallen. In fruits with a free central placenta it is sometimes difficult to tell whether the dehiscence is septicidal or loculicidal, inasmuch as there are no dissepiments, and the placentas and seeds form a column in the axis. Their number, as well as alternation or opposition, as compared with the sepals, will aid in determining whether the valves are the entire carpellary leaves, as in septicidal dehiscence, or only half carpels united, as in loculicidal dehiscence. The other type of dehiscence is transverse, the dehiscence in this case being called *circumscissile*. In this dehiscence the upper part of the united carpels falls off in the form of a lid or operculum, as in Anagallis and in Henbane (Hyoscyamus) (fig. 291), and hence the fruit is often denominated *operculate*. In such instances we may either suppose that the fruit or seed-vessel is formed by a number of articulated leaves like those of the Orange, the division taking place where the laminæ join the petioles, or that the receptacle is prolonged in the form of a hollow cup, and the lid represents leaves united to it by articulation.

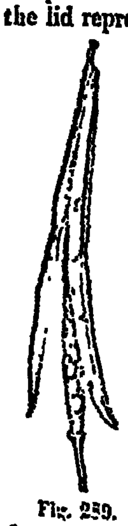

Fig. 291.

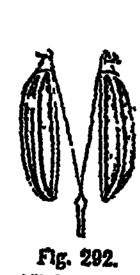

Fig. 290. Fig. 293.

Fig. 289. Fig. 292.

FIG. 289.—Siliqua or seed-vessel of Wallflower (*Cheiranthus Cheiri*), opening by two valves, which separate from the base upwards, leaving the seeds attached to the placentas in the middle, with a replum between.

FIG. 290.—Seed-vessel of an Orchid (*Orchis*), opening by three valves v v v, which bear the placentas and seeds in their middle. The midribs of the carpels remain united at the base and apex, and the withered floral envelopes e are seen attached at the apex.

FIG. 291.—Seed-vessel of Henbane (*Hyoscyamus niger*), opening by circumscissile dehiscence. The upper part of the seed-vessel comes off in the form of a lid, and the capsule has been on this account called pyxis or pyxidium.

FIG. 292.—The fruit of the Fennel (*Fœniculum vulgare*), arrived at maturity. It separates into two cocci or achænia, each of which is marked with obtuse prominent ridges on the surface, and is suspended from the summit of a process of the axis (columella), called a carpophore.

FIG. 293.—Lomentum or lomentaceous legume of a species of Sainfoin (*Hedysarum*). Each seed is contained in a separate cavity by the folding inwards of the walls of the legume at equal intervals; and the legume, when ripe, separates transversely into single-seeded portions or mericarps.

Sometimes the axis is prolonged beyond the base of the
III carpels, as in the Mallow and Castor-oil plant, the carpels being united to it throughout their length by their faces, and separating from it without opening. In the Umbelliferæ the two carpels separate from the lower part of the axis, and remain attached by their apices to a prolongation of it, called a *carpophore* or *podocarp*, which splits into two (fig. 292) and suspends them; hence the name *cremocarp* is applied to this fruit, which divides into two suspended mericarps. The general term *schizocarp* is applied to all dry fruits, which break up into two or more one-seeded indehiscent mericarps, as in Hedysarum (fig. 293). In Geraniaceæ the axis is prolonged beyond the carpels, forming a carpophore, to which the styles are attached, and the pericarps separate from below upwards, before dehiscing by their ventral suture (fig. 152). Carpels which separate one from another in this manner are called *cocci*. They are well seen in Euphorbiaceæ, where there are Plate XIII.
usually three such carpels, and the fruit is designated fig. 7.
tricoccous. In many of them, as Hura crepitans, the cocci separate with great force and elasticity, the cells being called *dissilient*. In many Leguminous plants, such as Ornithopus, Hedysarum (fig. 293), Entada, Coronilla, and the Gum-arabic plant (Acacia arabica), the fruit becomes a schizocarp by the formation of transverse partitions from the folding in of the sides of the pericarp, and distinct separations taking place at these partitions by what has been termed *solubility*. In Cathartocarpus Fistula the schizocarp exhibits no evident depressions externally. Some look upon these pods as formed by pinnate leaves folded, and the divisions as indicating the points where the different pairs of pinnæ are united.

Fruits may be formed by one flower, or they may be the product of several flowers combined. In the former case they are either *apocarpous*, of one mature carpel or of several separate free carpels; or *syncarpous*, of several carpels, more or less completely united. These different kinds of fruits may be *indehiscent* or *dehiscent*. When the fruit is composed of the ovaries of several flowers united, it is usual to find the bracts and floral envelopes also joined with them, so as to form one mass; hence such fruits are called *multiple*, *confluent*, or *anthocarpous*. The term *simple* is perhaps properly applied to fruits which are formed by the ovary of a single flower, whether they are composed of one or several carpels, and whether these carpels are separate or

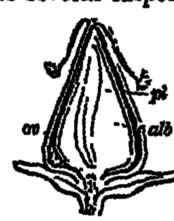

Fig. 294.

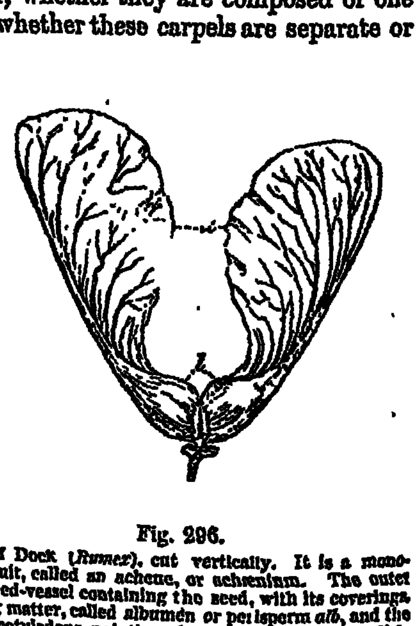

Fig. 295. Fig. 296.

FIG. 294.—Fruit of a species of Dock (*Rumex*), cut vertically. It is a monospermous indehiscent dry fruit, called an achene, or achænium. The outer part, ov, is the pericarp or seed-vessel containing the seed, with its coverings. The seed contains nourishing matter, called albumen or perisperm *alb*, and the embryo plant *pl*, with its cotyledons pointing downwards, and its radicle upwards. The seed is orthotropal, and the embryo is inverted. At the upper part of the pericarp two of the styles and stigmas are seen curving downwards. At the base part of the perianth is represented.

FIG. 295.—Achænium of Crowfoot (*Ranunculus*). A single-seeded seed-vessel, with the pericarp applied closely to the seed. Such fruits resemble seed in appearance; the style and stigma *s* aid in distinguishing them.

FIG. 296.—Seed-vessel of *Acer Pseudo-platanus* (Sycamore, called Plane in Scotland), composed of two samaras or winged monospermous carpels united; *a*, upper part forming a dorsal wing; *l*, lower portion corresponding to the loculaments.

combined. Simple fruits are hence sometimes denominated *monogynœcial*, as being formed by one gynœcium; while multiple fruits are called *polygynœcial*, as being formed by many gynœcia.

Simple fruits are either *dry* or *succulent*,—the pericarp, in the former instance, remaining more or less foliaceous in its structure, and sometimes being incorporated with the seed, while it is in the latter thick and fleshy or pulpy.

s of The *achænium* is a dry unilocular monospermous indehiscent fruit, the pericarp of which is closely applied to the seed, but separable from it. It may be *solitary*, forming a single fruit, as in the Dock (fig. 294), and in the
IV. Cashew, where it is supported on a fleshy peduncle; or *aggregate*, as in Ranunculus (figs. 254, 295), where several achænia are placed on a common elevated receptacle. In the Strawberry the achænia (fig. 154) are aggregated on a convex succulent receptacle. In the Rose they are supported on a concave receptacle (fig. 155), and in the Fig the succulent receptacle completely encloses the achenes (fig. 150). In Dorstenia (fig. 163) the achenes are situated on a flat or slightly concave receptacle. In the Rose the aggregate achænia with their covering are sometimes collectively called *cynarrhodum*. It will thus be remarked that what in common language are called the seeds of the Strawberry, Rose, and Fig, are in reality carpels, which are distinguished from seeds by the presence of styles and stigmas. The styles occasionally remain attached to the achænia, in the form of feathery appendages, as in Clematis, and they are called *caudate*. In Compositæ, the fruit,
e IX. which is sometimes called *cypsela*, is an achænium (fig. 197), to which the pappose or obsolete calyx remains adherent. Such is also the nature of the fruit in Dipsacaceæ. When the pericarp is thin, and appears like a bladder surrounding the seed, the achænium is termed a *utricle*, as in Amarantaceæ. When the pericarp is extended in the form of a winged appendage, a *samara* or *samaroid achænium* is produced, as in the Ash (fig. 281), Common Sycamore (fig. 296), and Hiræa. In these cases there are usually two achænia united, one of which, however, as in Fraxinus oxyphylla (fig. 281), may be abortive. The wing is either *dorsal*, that is, it is a prolongation from the median vein (fig. 296, *a*) or it is *marginal*, that is, formed by the lateral veins. It surrounds the fruit longitudinally in the Elm. When the pericarp becomes so incorporated with the seed as to be inseparable from it, as in grains of Wheat, Maize, Oats (fig. 297), and other Grasses, then the name

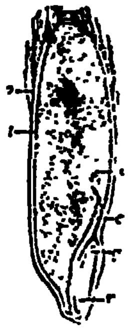

Fig. 297.

Fig. 298.

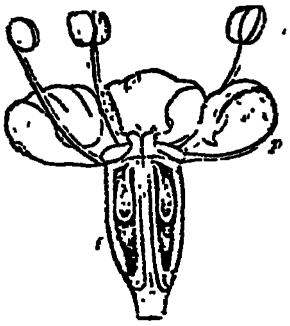

Fig. 299.

Fig. 297.—Caryopsis or single-seeded grain of Oats (*Avena*). The fruit and seed are incorporated. The pericarp *o* bears the styles and stigmas, and encloses the seed *t*, with its albumen, or perisperm, *a*, and its embryo, consisting of the cotyledon *c*, the gemmule *g*, and the root *r*.

Fig. 298.—Calyx and fruit of Comfrey (*Symphytum*), cut vertically. The fruit is divided by the folding of the ovary into four single-seeded portions or achænia, two of which are seen in the figure, and the style appears to arise from the base of the carpels.

Fig. 299.—Flower of Fennel (*Fœniculum vulgare*), one of the Umbelliferæ, cut vertically, showing the fruit *f*, composed of two single-seeded carpels, or achenes, united, so as to form a cremocarp. The pendulous seeds are seen in the carpels or mericarps. The two styles are seen at the apex of the fruit, with their dilated bases formed by an epigynous disk. The points (apicula) of the petals *p* are turned inwards. The calyx tube is adherent to the fruit, and the limb of the calyx is often obsolete.

caryopsis is given. There are some fruits which consist of two or more achænia, although originally the carpels were united into a syncarpous pistil, as in Labiatæ and Boraginaceæ (fig. 298). To this form of schizocarpic fruit,
ate III. as well as to that of Tropæolum and Mallow, the name *carcerulus* is given. The *cremocarp*, or the fruit of Umbelliferæ (figs. 292 and 299), is composed of two achænia Plate VI.
united by a commissure to a *carpophore*, from which they are suspended at maturity. It is sometimes denominated *diachænium*, from the union of two achænia, which in this instance receive the name of *mericarps* or *hemicarps*.

The *nut* or *glans* is a dry one-celled indehiscent fruit with a hardened pericarp, surrounded by bracts at the base, and, when mature, containing only one seed. In the young state the ovary contains two or more ovules, but only one comes to maturity. It is illustrated by the fruits of the Hazel and Chestnut, which are covered by leafy bracts, in the form of a *husk*, and by the Acorn, in which the bracts and receptacle form a *cupula* or *cup* (fig. 147). The parts of the pericarp of the nut are united so as to appear one. In common language the term nut is very vaguely applied both to fruit and seeds.

The *drupe* is a succulent usually monospermal and unilocular indehiscent fruit, with a pericarp easily distinguishable into epicarp, mesocarp, and endocarp. This term is applied to such fruits as the Cherry (fig. 282), Peach, Plate XII.
Plum, Apricot, Mango, Walnut, Nutmeg, and Date. The endocarp is usually hard, forming the stone (*putamen*) of the fruit, which encloses the kernel or seed. The mesocarp is generally pulpy and succulent, so as to be truly a *sarcocarp*, as in the Peach, but it is sometimes of a tough texture, as in the Almond, and at other times is more or less fibrous, as in the Coco-nut. In the Almond there are often two ovules formed, only one of which comes to perfection. In the Walnut, prolongations from the endocarp, which is of two layers, extend into the substance of the seed, and give rise to its characteristic convoluted lobate appearance. This fruit has been sometimes called *tryma*. In the Raspberry and Bramble several drupes or *drupels* are aggregated so as to constitute an *etærio*.

The *follicle* is a dry monocarpellary unilocular polyspermal (many-seeded) fruit, dehiscing by the ventral suture. It is rare to meet with a solitary follicle forming the fruit. There are usually several aggregated together, either in a circular manner on a shortened receptacle, as in Hellebore, Aconite, Delphinium, Aquilegia (figs. 300, 301) Crassulaceæ (fig. 172), Butomus, and Asclepiadaceæ; or in a spiral manner on an elongated receptacle, as in Magnolia, Banksia, and Liriodendron. Occasionally, follicles dehisce by the dorsal suture, as in Magnolia grandiflora and Banksia.

The *legume* or *pod* is a dry monocarpellary unilocular polyspermal fruit, dehiscing both by the ventral and the dorsal Plate V
suture. It characterises Leguminous plants, as the Bean fig. 7.
and Pea (fig. 256). In the Bladder-senna it retains its leaf-like appearance, and forms an inflated legume. In some Leguminosæ, as Arachis, Cathartocarpus Fistula, and the Tamarind, the fruit must be considered a legume, although it does not dehisce. The first of these plants produces its fruit underground, and is called earth-nut; the second has a partitioned legume and is schizocarpic; and both the second and third have pulpy matter surrounding the seeds. Some legumes are schizocarpic by the formation of constrictions externally. Such a form is the [illegible]

mass, formed by the placentas. The name is usually given to such fruits as the Gooseberry (fig. 302) and Currant, in which the ovary is inferior, and the placentas are parietal, the seeds being ultimately detached from the placenta, and

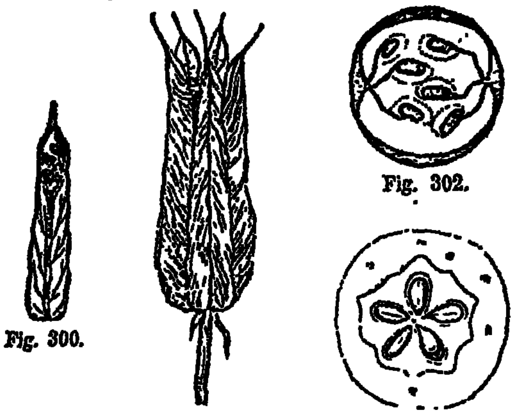

Fig. 300. Fig. 301. Fig. 302. Fig. 303.

FIG. 300.—Follicle of Columbine (*Aquilegia vulgaris*), consisting of a polyspermal carpel, opening by the ventral suture.
FIG. 301.—Apocarpous fruit of Columbine (*Aquilegia vulgaris*), consisting of five separate mature carpels, with styles and stigmas.
FIG. 302.—Fruit of the Gooseberry (*Ribes Grossularia*), cut vertically, showing the seeds attached to parietal placentas, and immersed in pulpy matter, which is formed partly from the endocarp and partly from the testa of the seed. The fruit is called a bacca.
FIG. 303.—Section of the fruit of the Apple (*Pyrus Malus*), consisting of a fleshy covering partly formed by the calyx and disk, and five cavities in the centre with seeds. The fruit is called a pome.

lying loose in the pulp. Others have applied it also to those in which the ovary is superior, as in the Grape, Potato, and Ardisia, and the placentas are central or free central. The latter are frequently separated under the name *uva* (grape). In general, the name of *baccate* or *berried* is applied to all pulpy fruits. In the Pomegranate there is a peculiar baccate many-called inferior fruit, having a tough rind, enclosing two rows of carpels placed one above the other. The seeds are immersed in pulp, and are attached irregularly to the parietes, base, and centre of the loculi. The fruit has been called *balausta*, and the tough rind is called *malicorium*. In the Baobab there is a multilocular syncarpous fruit, in which the seeds are immersed in pulp, to which the name *amphisarca* is given.

The *pepo* or *peponida*, another indehiscent syncarpous fruit, is illustrated by the fruit of the Gourd, Melon (fig. 262), and other Cucurbitaceæ. It is formed of three carpels, to which the calyx is superior; the rind is thick and fleshy, partly formed by the calyx; and there are three or more seed-bearing parietal placentas, either surrounding
Plate VI. a central cavity, or prolonged inwards into it. The fruit of the Papaw resembles the pepo, but the calyx is not superior.

The *hesperidium* is the name given to such indehiscent syncarpous fruits as the Orange, Lemon, and Shaddock, in which the epicarp and mesocarp form a separable rind, and the endocarp sends prolongations inwards, forming triangular divisions, to the inner angle of which the seeds are attached, pulpy cells being developed around them. Both pepo and hesperidium may be considered as modifications of the berry.

The *pome*, seen in the Apple, Pear, Quince, Medlar, and Hawthorn, is a fleshy indehiscent syncarpous fruit with the calyx attached, and has an outer skin or epicarp, a fleshy mesocarp, and a scaly or horny endocarp (the *core*) enclosing the seeds (fig. 303). Some look upon the so-called epicarp and mesocarp as formed by the prolonged receptacle on the inner surface of which a fleshy lining is developed, while the endocarp represents the true carpels. In this view the docarp might be regarded as consisting of a number of lehiscent follicles (usually five) surrounded by a succulent ceptacle. In the Medlar the endocarp (or what may be called the true pericarp) is of a stony hardness, while the outer succulent covering is open at the summit. The stones of the Medlar are called *pyrenæ*; some apply the term *nuculanium* to the Medlar. Taking this view of the pome it may be said to resemble in a manner the fruit of the Rose, the cynarrhodum producing achenes, and the pome closed follicles.

The name *capsule* is applied generally to all dry syncarpous fruits, which dehisce by valves of whatever kind. Plate X. fig. 6. Plate XI fig. 5.
It may thus be unilocular or multilocular, monospermous or polyspermous. The true valvular capsule is observed in Colchicum (fig. 284), Lily, and Iris (fig. 286). The *porose capsule* is seen in the Poppy (fig. 269), Antirrhinum majus, Plate I.
and Campanula persicifolia. In Campanula the pores occur at the base of the capsule, and it has been designated a *diplotegia*. When the capsule opens by a lid, or by circumscissile dehiscence, it is called a *pyxidium*, as in Anagallis arvensis, Henbane (fig. 291), and Monkey pot (Lecythis). The capsule assumes a screw-like form in Helicteres, and a star-like or stellate form in Illicium anisatum. In certain instances the cells of the capsule separate from each other, and open with elasticity to scatter the seeds. This kind of capsule is met with in the Sandbox tree (Hura crepitans), and other Euphorbiaceæ, Plate XIII.
where the cocci, containing each a single seed, burst asunder fig. 7.
with force; and in Geraniaceæ, where the cocci, each con- Plate II.
taining, when mature, usually one seed, separate from the carpophore, become curved upwards by their adherent styles, and open by the ventral suture (fig. 152). In the former case the fruit collectively has been called *regma*.

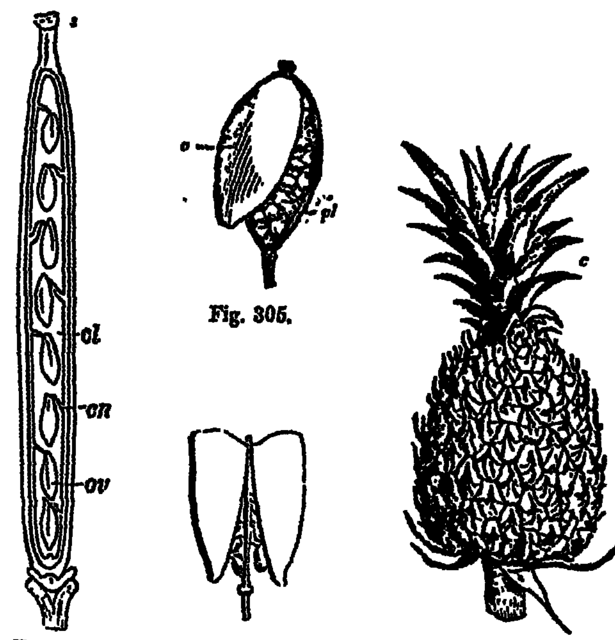

Fig. 304. Fig. 305. Fig. 306. Fig. 307.

FIG. 304.—Compound ovary (siliqua) of Wallflower (*Cheiranthus*), consisting of at least two carpels united. One valve has been removed to show the partition or replum *cl*, formed of a double layer from the placentæ *cn* on either side, to which the ovules *ov* are attached by means of funiculi. The style and stigma *s* are at the upper part of the ovary.
FIG. 305.—Silicula of Whitlow-grass (*Draba*), opening by two flat valves *o* from below upwards, leaving the parietal placentas *pl* in the centre, united by a membrane or replum. The partition of the seed-vessel is broad, and hence the name latiseptæ.
FIG. 306.—Silicula or pouch of Shepherd's purse (*Capsella*), opening by two folded valves, which separate from below upwards. The phragma is narrow, and hence the name angustiseptæ.
FIG. 307.—Fruit of the Pine-apple (*Ananassa sativa*), consisting of numerous flowers and bracts united together so as to form a collective or anthocarpous fruit. The crown of the Pine-apple, *c*, consists of a series of empty bracts prolonged beyond the fruit.

The *siliqua* is a dry syncarpous bicarpellary bilocular polyspermal fruit with a replum, dehiscing by two valves from below upwards, the valves separating from the placentas and leaving them united by the replum. The seeds are attached on both sides of the replum, either in one row or in two. When the fruit is long and narrow it

is called *siliqua* (fig. 304); when broad and short, it is called *silicula* (figs. 305, 306). It occurs in Cruciferous plants, as Wallflower, Cabbage, and Cress. In Glaucium and Eschscholtzia (Papaveraceous plants) the fruit is siliquæform, the dissepiment or replum being of a spongy nature, and it has been termed a *ceratium*. In its normal state a siliqua is supposed to consist of four carpels, but two of these are abortive. There are four bundles of vessels in it, one corresponding to each valve which may be called *valvular* or *pericarpial*, and others running along the edge called *placental*. The replum consists of two lamellæ. It sometimes exhibits perforations, becoming *fenestrate*. Rarely its central portion is absorbed, so that the fruit becomes one-celled. It may become *lomentaceous*, as in Raphanus and Sea-kale, and it may be reduced, as in Woad (Isatis), to a monospermal condition.

It sometimes happens that the ovaries of two flowers unite so as to form a double fruit. This may be seen in many species of Honeysuckle. But the fruits which are now to be considered consist usually of the floral envelopes, as well as the ovaries of several flowers united into one, and are called *multiple*, *confluent*, or *polygynœcial*. The term *anthocarpous* has also been applied as indicating that the floral envelopes as well as the carpels are concerned in the formation of the fruit.

The *sorosis* is a succulent multiple fruit formed by the confluence of a spike of flowers, as in the fruit of the
to XIV. Pine-apple (fig. 307), the Bread-fruit, and Jack-fruit. Sometimes a fruit of this kind resembles that formed by a single flower, and a superficial observer might have some difficulty in marking the difference.

The *syconus* is an anthocarpous fruit, in which the receptacle completely encloses numerous flowers and becomes succulent. The Fig (fig. 150) is of this nature, and what are called its seeds are the achænia of the numerous flowers scattered over the succulent hollowed receptacle. In Dorstenia (fig. 163) the axis is less deeply hollowed, and of a harder texture, the fruit exhibiting often very anomalous forms.

The *strobilus*, or *cone*, is a fruit-bearing spike, more or less elongated, covered with scales (fig. 134), each of which represents a separate flower, and has often two seeds at its base, the scales being considered as bracts and the seeds naked, and no true ovary present with its style or stigma. This fruit is seen in the cones of Firs, Spruces, Larches, and Cedars, which have received the name of Coniferæ, or cone-bearers, on this account. Cone-like fruit is also seen in some Cycadaceæ. The scales of the strobilus are sometimes thick and closely united, so as to form a more or less angular and rounded mass, as in the Cypress; while in the Juniper they become fleshy, and are so incorporated as to form a globular fruit like a berry. The dry fruit of the Cypress, and the succulent fruit of the Juniper, have received the name of *galbulus*. The fruit of the Yew (Taxus baccata) is regarded as a cone reduced to a single naked seed, covered by succulent scales, which unite to form a scarlet fleshy envelope. In the Hop the fruit is called also a strobilus, but in it the scales are thin and membranous, and the seeds are not naked but are contained in pericarps.

The same causes which produce alterations in the other parts of the flower give rise to anomalous appearances in the fruit. The carpels, in place of bearing seeds, are sometimes changed into leaves, with lobes at their margins. Leaves are sometimes produced from the upper part of the fruit, which is then called *frondiparous*. In the genus Citrus, to which the Orange and Lemon belong, it is very common to meet with a separation of the carpels, so as to produce what are called horned oranges and fingered citrons. In this case a syncarpous fruit has a tendency to become apocarpous. In the Orange we occasionally find a supernumerary row of carpels produced, giving rise to the appearance of small and imperfect oranges enclosed within the original one. The Navel Orange of Pernambuco is of this nature. It sometimes happens that, by the union of flowers, double fruits are produced. Occasionally a double fruit is produced, not by the incorporation of two flowers, but by the abnormal development of a second carpel in the flower.

ARRANGEMENT OF FRUITS.

I. Monogynœcial fruits, formed by the gynœcium of one flower.
  1. Capsulary fruits.—Dry, dehiscent, formed by one or more carpels; when by more than one, coherent.
     a. Monocarpellary.—Legume; Follicle.
     b. Polycarpellary.—Capsule; Pyxidium; Siliqua; Silicula; Ceratium; Diplotegia; Regma.
  2. Aggregate fruits.—Polycarpellary; carpels always distinct.
     a. Indehiscent.—Etærio; Strawberry; Cynarrhodum.
     b. Dehiscent.—Follicles (Columbine).
  3. Schizocarpic fruits.—Dry, breaking up into one-celled indehiscent portions.
     a. Monocarpellary.—Lomentum.
     b. Polycarpellary.—Cremocarp; Carcerulus; Samara (Acer).
  4. Achænial fruits.—Dry, indehiscent, one or few-seeded, not breaking up. Achænium; Caryopsis; Utricle; Samara (Elm); Cypsela; Glans.
  5. Baccate fruits.—Indehiscent; seeds in pulp. Bacca; Uva; Hesperidium; Pepo; Amphisarca; Balausta.
  6. Drupaceous fruits.—Indehiscent, succulent, endocarp indurated, usually stony. Drupe; Tryma; Pome; Nuculanium.

II. Polygynœcial fruits, formed by the gynœcia of several flowers.
  1. Succulent.—Sorosis; Syconus; Galbulus.
  2. Dry.—Strobilus; Cone.

b.—The Seed.

When the ovule arrives at maturity it constitutes the seed, which is contained in a seed-vessel in the plants called *angiospermous*; while in *gymnospermous plants*, such as Coniferæ and Cycadaceæ, it is naked, or, in other words, has no true pericarp. It sometimes happens in angiosperms, that the seed-vessel is ruptured at an early period of growth, so that the seeds become more or less exposed during their development; this occurs in Mignonette, where the capsule opens at the apex, and in Cuphea platycentra, where the placenta bursts through the ovary and floral envelopes, and appears as an erect process bearing the young seeds. After impregnation the ovule is greatly changed, in connection with the formation of the embryo. In the embryo-sac of most angiosperms there is a development of cellular tissue, enveloping, when not previously absorbed, the *antipodal cells*, and more or less filling the embryo sac. In gymnosperms, as already mentioned, the endosperm is formed preparatory to fertilization. The germinal vesicle in angiosperms, the central cell of the corpuscle in cryptogams, enlarges and divides, forming the embryo. The embryo-sac enlarges greatly, displacing gradually the nucleus, which may eventually form merely a thin layer around the sac, or it may completely disappear. The integuments also become much altered, and frequently appendages are developed from them. The seed

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sac, or of one of thes
secundine remains distin
been called a [illegible]

character, it has received the name of *sarcosperm* or *sarcoderm*. The nature of the testa depends upon that of the pericarp. When the pericarp is dehiscent then the seed-covering is of a strong and tough character; but when

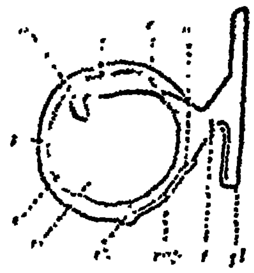

Fig. 308.

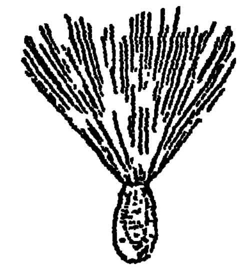

Fig. 309.

FIG. 308.—Seed (ovule) of the Pea (*Pisum*), deprived of one-half of its integument or spermoderm. The outer covering, called either episperm, exosperm, or testa, is marked t, the inner, called endopleura, e. Within these integuments is the embryo, consisting of cotyledons or seed-lobes c containing nourishing matter, the gemmule or young leaf-bud g, the radicle or young root r, the tigelle or stalk between root and bud t. The seed is attached to the placenta *pl* by a cord or funiculus *f*. The nourishing vessels *vsp* enter the nucleus at the chalaza ch, and the root of the embryo points to the micropyle or foramen *m*.
FIG. 309.—Seed of Asclepias, with a cluster of hairs arising from the edges of the micropyle, and by some considered as a hairy aril. These hairs are for the purpose of scattering the seed.

the pericarp is indehiscent and encloses the seed for a long period, its outer covering has a proportional softness. The cells of the testa are often coloured, and have projections and appendages of various kinds. Thus in Abrus precatorius and Adenanthera pavonina it is of a bright red colour; in French beans it is beautifully mottled; in the Almond it is veined; in the Tulip and Primrose it is rough; in the Snapdragon it is marked with depressions; in Cotton and Asclepias (fig. 309) it has hairs attached to it; and in *Mahogany*, *Bignonia*, and Firs it is expanded in the form of wing-like appendages (fig. 310). In Collomia, Acanthodium, and other seeds, it contains spiral cells, from which, when moistened with water, the fibres uncoil in a beautiful manner; so also in Cobæa scandens and Calempelis scaber. In the testa of the seed of *Ulmus campestris* the cells are compressed, and their sinuous boundaries are traced out by minute rectangular crystals adhering to their walls; and in such plants as the Flax (Linum) the cells are converted into mucilage. These structural peculiarities of the testa in different plants have relation to the scattering of the seed and its germination upon a suitable nidus. But in some plants the pericarps assume structures which subserve the same purpose; this especially occurs in small pericarps enclosing single seeds, as achenes, caryopsides, &c. Thus
Plate VIII fig. 3 in Compositæ (fig. 197) and Valerian, the pappose limb of the calyx forms a parachute to the pericarp; in Labiatæ and some Compositæ spiral cells are formed in the epicarp; and the epicarp is prolonged as a wing in Fraxinus (fig. 281) and Acer (fig. 296)

covering formed around the naked seed in the Yew is by some considered of the nature of an aril. On the testa, at various points, there are produced at times cellular bodies, which are not dependent on fertilization, to which the name of *strophioles*, or *caruncules*, has been given, the Plate II.
seeds being strophiolate or carunculate. These tumours fig. 5.
may occur near the base of the seed, as in Polygala, or at the apex, as in Ricinus, where they are swellings of the exostome; or they may occur in the course of the raphe, as in Blood-root and Asarabacca. The funiculi of the ovules frequently attain a great length in the seed, and in some Magnolias, when the fruit dehisces, they appear as long scarlet cords suspending the seeds outside. The hilum or umbilicus of the seed is usually well marked, as a scar of varying size, in the Calabar bean and in some species of Mucuna and Dolichos, extending along a large portion of the edge of the seed; and it frequently exhibits marked colours, being black in the Bean, white in many species of Phaseolus, &c. The *micropyle* (fig. 308, *m*) of the seed, with its exostome and endostome, may be recognizable by the naked eye, as in the Pea and Bean tribe, Iris, &c., or it may be very minute or microscopic. It indicates the true apex of the seed, and is important as marking the point to which the root of the embryo is directed. At the micropyle in the Bean is observed a small process of integument, which, when the young plant sprouts, is pushed up like a lid, and is called *embryotega*. The *chalaza* (fig. 311, *ch*) is often of a different colour from the rest of the seed. In the Orange (fig. 313) it is of a reddish-brown colour, and is easily recognized at one end of the seed when the integuments are carefully removed. In anatropal seeds the raphe forms a distinct ridge along one side of the seed (fig. 314).

Fig. 310.

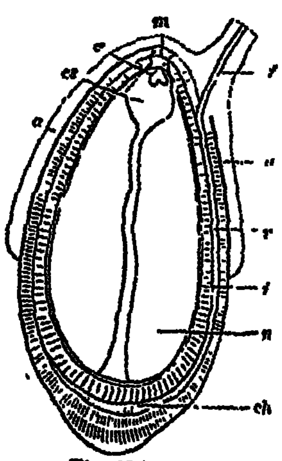

Fig. 311.

Fig. 312.

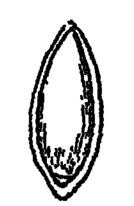

Fig. 313.

FIG. 310.—Seed of Fir (*Pinus*), with a membranous appendage *w* to the testa, called a wing. The seed is said to be *winged*.
FIG. 311.—Young anatropal seed of the White Water-lily (*Nymphæa alba*), cut vertically. It is attached to the placenta by the funiculus or umbilical cord *f*, cellular prolongations from which *form an aril a a*. The vessels of the cord are prolonged to the base of the nucleus *n* by means of the raphe *r*, composed of cells and spiral vessels. The base of the nucleus is indicated by the chalaza *ch*, while the apex is at the micropyle *m*. The covering of the seed is marked *t*. *n* is the nucleus or perisperm, surrounded by its covering, and enclosing the embryo-sac *cs*, in which the endosperm is formed. The embryo *e*, with its suspensor, is contained in the sac, the radicle pointing to the micropyle *m*.
FIG. 312.—Arillode *a*, or false aril, of the Spindle-tree (*Euonymus*), arising from the micropyle *f*.
FIG. 313.—Anatropal seed of the Orange (*Citrus Aurantium*) opened to show the chalaza *c*, which forms a brown spot at one end.

The position of the seed as regards the pericarp resembles that of the *ovule* in the ovary, and the same terms are applied—erect, ascending, pendulous, suspended, curved, &c. These terms have no reference to the mode in which the fruit is attached to the axis. Thus the seed may be erect while the fruit itself is pendent, in the ordinary meaning of that term. The part of the seed next the axis or the ventral suture is its *face*, the opposite side being the *back*. Seeds exhibit great varieties of form. They may be flattened laterally (*compressed*), or from above

downwards (*depressed*). They may be round, oval, triangular, polygonal, rolled up like a snail, as in Physostemon, or coiled up like a snake, as in Ophiocaryon paradoxum.

The endosperm formed in the embryo-sac of angiosperms after fertilization, and found previous to it in gymnosperms, consists of cells containing protoplasmic substance and starchy or fatty matter, or both, destined for the nutriment of the embryo. It arises by free-cell division from the protoplasm of the embryo-sac,—and may occupy the whole cavity of the embryo-sac, or may be formed only at certain portions of it, at the apex, as in Rhinanthus, at the base, as in Vaccinium, or in the middle, as in Veronica. As the endosperm increases in size along with the embryo-sac and the embryo, the substance of the original nucleus of the ovule is gradually absorbed, and usually at last disappears except the layer constituting the endopleura, and in some cases this goes also. Sometimes, however, as in Musaceæ, Cannaceæ, Zingiberaceæ, no endosperm is formed; the cells of the original nucleus, becoming filled with food-materials for the embryo, are not absorbed, but remain surrounding the embryo-sac with the embryo, and constitute the *perisperm*. Again, in other plants, as Nymphæaceæ (fig. 311) and Piperaceæ, both endosperm and perisperm are present. It was from observations on cases such as these that old authors, imagining a resemblance betwixt the plant-ovule and the animal ovum, applied the name *albumen* to the outer nutrient mass or perisperm, and designated the endosperm as *vitellus*. The term albumen is very generally used as including all the nutrient matter stored up as a separate mass in the ovule, but it would be advisable to discard the name as implying a definite chemical substance. There is a large class of plants in which although at first after fertilization a mass of endosperm is formed, yet, as the embryo increases in size, the nutrient matter from the endospermic cells passes out from them, and is absorbed by the cells of the embryo plant. In the mature seed, in such cases, there is no separate mass of tissue containing nutrient food-material apart from the embryo itself. Such a seed is said to be *exalbuminous*, as in Compositæ, Cruciferæ, and most Leguminosæ. When either endosperm or perisperm or both are present the seed is said to be *albuminous*.

The albumen varies much in its nature and consistence, and furnishes important characters. It may be *farinaceous* or *mealy*, consisting chiefly of cells filled with starch, as in cereal grains, where it is abundant; *fleshy* or *cartilaginous*, consisting of thicker cells which are still soft, as in the Coco-nut, and which sometimes contain oil, as in the oily albumen of Croton, Ricinus, and Poppy; *horny*, when the cell-walls are slightly thickened and capable of distension, as in Date and Coffee; and they sometimes become greatly thickened, filling up the testa as a hard mass, as in Vegetable Ivory. The albumen may be uniform throughout, or it
late XII may present a mottled appearance, as in the Nutmeg, the
g. 11. seeds of Anonaceæ, and some Palms, where it is called *ruminated*. This mottled appearance is due to a protrusion of a dark lamella of the endopleura between folded protuberances of albumen. The endosperm within the embryo-sac is developed from the protoplasm of that sac, but in many cases as it grows inward the whole protoplasm is not converted into a solid mass, but a cavity is left in the centre which is usually filled with fluid, as in the Coco-nut. In the thickened albumen of this Palm, as well as in that of the Attalea funifera, the Date, and the Doum Palm, the small cavity in the centre and radiating spaces are well seen under the microscope. The albumen is a store of matter laid up for the nourishment of the embryo. The relative size of the embryo and of the endosperm varies much. In Monocotyledons the embryo is usually small, and the endosperm large, and the same is true in the case of Coffee and many other plants amongst Dicotyledons. The opposite is the case in other plants, as in the Labiatæ, Plumbaginaceæ, &c.

In angiosperms after fertilization the embryonal vesicle undergoes changes by which the embryo plant is eventually formed. The portion of the vesicle nearest the apex of the embryo-sac coalesces with it. The lower portion enlarges and lengthens greatly, and divides by transverse partition until a large terminal cell is formed at the extremity of a *suspensor or proembryo* (figs. 316, 317), formed of smaller cells. It is this terminal cell which immediately forms the The embryo.

Fig. 314.

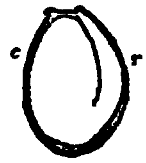

Fig. 315.

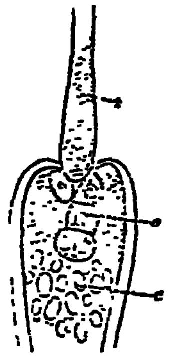

Fig. 316.

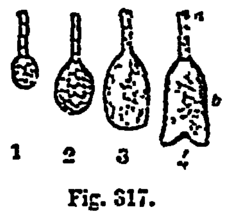

Fig. 317.

Fig. 314.—Entire anatropal seed of the Orange (*Citrus Aurantium*), with its rugose or wrinkled testa, and the raphe *r* ramifying in the thickness of the testa on one side.

Fig. 315.—Seed of Wallflower (*Cheiranthus*) cut vertically. The seed is exalbuminous or aperispermic—all the nourishing matter being incorporated with the cotyledons *c*. On removing the integument which is marked by the dark lines, the embryo alone is found in the interior. The radicle *r* is folded on the edges of the cotyledons, which are accumbent. The plant belongs to the division of Cruciferæ, called Pleurorhizeæ.

Fig. 316.—Section of the ovule of *Œnothera*, showing the pollen-tube *t*, with its enlarged extremity applied to the end of the embryo-sac, and introverting it slightly; the germinal vesicle in the sac has been impregnated, and has divided into two parts, the upper part forming a confervoid septate suspensor *s*, and the lower dividing into four parts, which form a globular mass—the rudimentary embryo, surrounded by endospermal cells *e*.

Fig. 317.—A Dicotyledonous embryo, in different stages of development, within the seed. At 1 it appears as a globular cellular mass at the extremity of a cellular cord or suspensor; at 2 it becomes more ovoid; it enlarges still more at 3; and at 4 it presents two distinct portions,—*a*, the radicle attached to the suspensor, and *b*, the two cotyledons.

embryo. By longitudinal growth the terminal cell becomes pushed into the endosperm (when present) of the sac, and becomes completely surrounded by it. In the lower part of the central cell of gymnosperms a cell is produced which divides until a proembryo is formed, which elongates and bursts through the central cell. The divisions in this proembryo take place so that several suspensors are formed, penetrating the endosperm. Usually, each of these elongates and bears a large cell at its extremity, which becomes an embryo; thus polyembryony occurs. The terminal cell of the proembryo in both angiosperms and gymnosperms increases in size, and divides repeatedly, until a cellular axis is formed. This is the rudiment of the embryo. Upon this axial mass, one, two, or more rounded cellular protuberances appear, the indications of the first leaves or cotyledons; and at the point where the embryo joins the proembryo is

the embryo, especially in Monocotyledons, and these arise as cellular processes from the outer or pericambial layer of the plerome in the hypocotyledonary portion of the axis. The primary root of the embryo is, by reason of its formation, always directed to the micropyle. In Monocotyledons and some Dicotyledons the young root rises deep in the tissues of the embryo, which, when it sprouts, form a sheath or coleorhiza around it. The lateral roots have also sheaths.

The embryo then consists of *cotyledons* (figs. 52, 53, 58, *c*), or the first leaves of the plant produced upon a cellular axial mass. To that part of this axis immediately beneath the cotyledons the terms *hypocotyledonary portion, caulicle*, or *tigellus* (*t*) have been applied, and continuous backwards with it is the young root or *radicle* (*r*), the descending axis, their point of union being the *collum*, collar, or neck. The terminal growing bud of the axis is called the *plumule* or *gemmule* (*g*), and represents the ascending axis. That extremity of the embryo which produces the first leaves or cotyledons is called the *cotyledonary* extremity of the embryo, while the opposite is the *radicular* extremity. The radicular extremity being continuous with the suspensor points towards the micropyle (fig. 318), or the summit of the nucleus, an important fact in practical botany; while the cotyledonary extremity is pointed towards the base of the nucleus or the chalaza. Hence, by ascertaining the position of the micropyle and chalaza, the two extremities of the embryo can in general be discovered. In some rare instances, in consequence of a thickening in the coats of the seed, as in Ricinus and some other Euphorbiaceæ, there is an alteration in the micropyle, so that the radicle does not point directly to it. It is in many cases difficult to recognize the parts in an embryo; thus in Cuscuta, the embryo appears as an elongated axis without divisions; and in Caryocar butyrosum, the mass of the embryo is made up by the radicular extremity and tigelle, in a groove of which the cotyledonary extremity lies embedded. In some Monocotyledonous embryos, as in Orchidaceæ, the parts of the embryo of the ripe seed are not differentiated, and only become so after germination. In parasitic plants which form no chlorophyll, as Orobanche, Monotropa, &c., the embryo remains without differentiation, consisting merely of a mass of cells until the ripening of the seed. When the embryo is surrounded by the endosperm on all sides except its radicular extremity it becomes *internal* or *intrarius;* when lying outside the endosperm, and only coming into contact with it at certain points, it is *external* or *extrarius*. When the embryo follows the direction of the axis of the seed, it is *axile* or *axial* (fig. 318), and it may be either *external*, so as to come into contact with the endosperm only by its cotyledonary apex, or *internal*. In the latter case the radicular extremity may, as in some Coniferæ, become incorporated with the endosperm apparently by means of a thickened suspensor. When the embryo is not in the direction of the axis, it becomes *abaxile* or *abaxial;* and in this case it may be either straight or curved, internal or external. In campylotropal seeds the embryo is curved, and in place of being embedded in endosperm, is frequently external to it, following the concavity of the seed (fig. 319), and becoming *peripherical*, with the chalaza situated in the curvature of the embryo, as in Caryophyllaceæ

It has been already stated that the radicle of the embryo is directed to the micropyle, and the cotyledons to the chalaza. In some cases, by the growth of the integuments, the former is turned round so as not to correspond with the apex of the nucleus, and then the embryo has the radicle directed to one side, and is called *excentric*, as is seen in Primulaceæ, Plantaginaceæ, and many Palms, especially the Date. The position of the embryo in different kinds of seeds varies. In an orthotropal seed the embryo is inverted or *antitropal*, the radicle pointing to the apex of the seed, or to the part opposite the hilum. Again, in an anatropal seed the embryo is *erect* or *homotropal* (fig. 318), the radicle being directed to the base of the seed. In some anatropal seeds, as in Castor oil, the exostome is thickened or carunculate, and the endostome does not correspond exactly to it, so that the radicle of the embryo is directed to a point a little removed from the exostome. In curved or campylotropal seeds the embryo is folded so that its radicular and cotyledonary extremities are approximated, and it becomes *amphitropal*. In this instance the seed may be exalbuminous, and the embryo may be folded on itself; or albuminous, the embryo surrounding more or less completely the endosperm, and being peripherical. According to the mode in which the seed is attached to the pericarp, the radicle may be directed upwards or downwards, or laterally, as regards the ovary. In an orthotropal seed attached to the base of the pericarp it is superior, as also in a suspended anatropal seed. In other anatropal seeds the radical is inferior. When the seed is horizontal as regards the pericarp, the radicle is either centrifugal, when it points to the outer wall of the ovary; or centripetal, when it points to the axis or inner wall of the ovary.

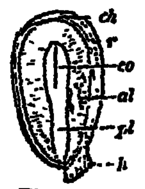

Fig. 318.

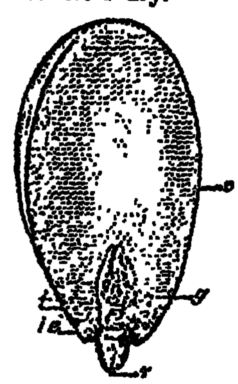

Fig. 321.

Fig. 319.

Fig. 320.

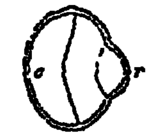

Fig. 322.

FIG. 318.—The seed of the Pansy (*Viola tricolor*) cut vertically. The embryo *pl* is axial, in the midst of fleshy albumen *al*. The seed is anatropal, and the embryo is homotropal; the cotyledons *co* point to the base of the nucleus or chalaza *ch*, while the radicle, or the other extremity of the embryo, points to the foramen, close to the hilum *h*. The hilum or base of the seed, and the chalaza or base of the nucleus are united by means of the raphe *r*.

FIG. 319.—Seed of the Red Campion (*Lychnis*), cut vertically, showing the peripherical embryo, with its two cotyledons and its radicle. The embryo is curved round the albumen, so that its cotyledons and radicle both come near the hilum. The embryo is sometimes called amphitropal.

FIG. 320.—Mature Dicotyledonous embryo of the common Almond, with one of the cotyledons removed; *r*, radicle; *t*, tigelle or caulicule; *c*, one of the cotyledons left; *tc*, cicatrix left at the place where the other cotyledon was attached; *g*, gemmule composed of several small leaves.

FIG. 321.—Transverse section of the seed of the Wallflower (*Cheiranthus*). The radicle *r* is folded on the edges of the cotyledons *c*, which are said to be accumbent.

FIG. 322.—Transverse section of the seed of the Dame's Violet (*Hesperis*) The radicle *r* is folded on the back of the cotyledons *c*, which are said to be incumbent

Plants in which there are two cotyledons produced in the embryo are *Dicotyledonous*. The form of this embryo varies much; and although sometimes resembling in its general aspect that of Monocotyledons, yet it is always distinguished by a division taking place at the cotyledonary extremity (fig. 317), by which two, more or less evident, lobes are formed. The two cotyledons thus formed are opposite to each other (figs. 58 and 320). The cotyledons are not always, however, of the same size. Thus, in a species of Hiræa, one of them is smaller than the other, and in Carapa guianensis there appears to be only one, in consequence of the intimate union which takes place between the two. The union between the cotyledonary leaves may continue after the young plant begins to germinate. Such embryos have been called *pseudo-monocotyledonous*. The texture of the cotyledons varies. They may be thick, as in the Pea (fig. 58), exhibiting only slight traces of venation, with their flat internal surfaces in contact, and their backs more or less convex; or they may be in the form of thin and delicate laminæ,

flattened on both sides, and having distinct venation, as in Ricinus, Jatropha, Euonymus, &c. In the former case they are called *fleshy*, or seminal lobes; in the latter, *foliaceous*, or seminal leaves. The cotyledons usually form the greater part of the mature embryo, and this is remarkably well seen in such exalbuminous seeds as the Bean and Pea.

Cotyledons are usually entire and sessile. But they occasionally become lobed, as in the Walnut and the Lime, where there are five lobes; or petiolate, as in Geranium molle; or auriculate, as in the Ash. Like leaves in the bud, cotyledons may be either applied directly to each other, or may be folded in various ways. In Geranium the cotyledons are twisted and doubled; in Convolvulus they are corrugated; and in the Potato and in Bunias, they are spiral,—the same terms being applied as to the foliage leaves. The radicle and cotyledons may be either straight or curved in various ways. Thus, in some Cruciferous plants, as the Wallflower, the cotyledons are applied by their faces, and the radicle (fig. 321) is folded on their edges, so as to be *lateral;* the cotyledons are here *accumbent.* In others, as the Hesperis, the cotyledons (fig. 322) are applied to each other by their faces, and the radicle, *r*, is folded on their back, so as to be *dorsal*, and the cotyledons are *incumbent.* Again, the cotyledons are *conduplicate* when the radicle is dorsal, and enclosed between their folds. In other divisions the radicle is folded in a spiral manner, and the cotyledons follow the same course.

In many gymnosperms more than two cotyledons are present, and they are arranged in a whorl. This occurs in Coniferæ, especially in the Fir (fig. 323), Spruce, and Larch, in which six, nine, twelve, and even fifteen have been observed. They are linear, and resemble in their form and mode of development the clustered or fasciculated leaves of the Larch. Plants having numerous cotyledons are occasionally denominated *polycotyledonous.* In the gymnospermous genus Welwitschia, there are two cotyledons which last throughout its life (more than a century), and in the course of time they grow to an enormous size, being sometimes six feet long and two or three feet in breadth. They constitute the only leaves of the plant. In species of Streptocarpus the cotyledons are also permanent, and act the part of leaves. One of them is frequently largely developed, while the other is small or abortive.

In those plants in which there is only a single cotyledon (fig. 53) in the embryo, hence called *Monocotyledonous*, the embryo usually has a cylindrical form more or less rounded at the extremities, or elongated and fusiform, often oblique. The axis is usually very short compared with the cotyledon, which in general encloses the plumule by its lower portion, and exhibits on one side a small slit which indicates the union of the edges of the vaginal or sheathing portion of the leaf (fig. 324). In Grasses, by the enlargement of the embryo in a particular direction, the endosperm is pushed on one side, and thus the embryo comes to lie outside at the base of the endosperm. The lamina of the cotyledon is not developed. Upon the side of the embryo next the endosperm and enveloping it is a large shield-shaped body, termed the *scutellum.* This is by some authors considered to be an outgrowth from the hypocotyledonary portion of the axis or expansion of the radicular extremity, enveloping more or less the cotyledon and plumule, in some cases, as in Maize, completely investing it; in other cases, as in Rice, merely sending small prolongations over its anterior face at the apex. By others this scutellum is considered as the true cotyledon, and the sheathing structure covering the plumule is regarded as a ligule or axillary stipule. In several other Monocotyledonous plants, as Ruppia and Zostera, this scutellar structure is well seen, and in these cases its homology, as an expansion of the radicular extremity of the embryo, is clearly discernible; and this is further borne out by such cases as that of Caryocar butyrosum among Dicotyledons, where the radicular swelling occupies most of the embryo (fig. 326). In some Grasses, as Oats and Rice, a projection

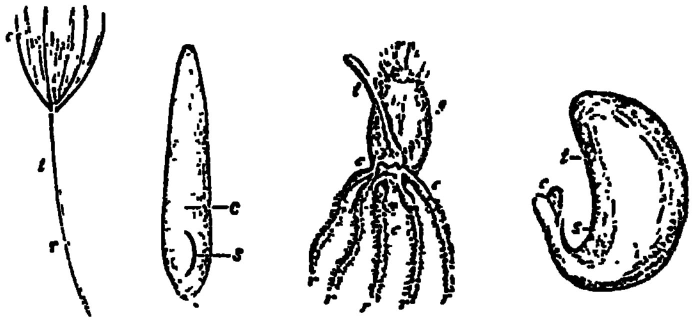

Fig. 323. Fig. 324. Fig. 325. Fig. 326.

Fig. 323.—Polycotyledonous embryo of the Pine (*Pinus*) beginning to sprout. The axis *t* shows its radicular portion *r* and cotyledonary portion *c*. The cotyledons *c* are numerous. Within the cotyledons the primordial leaves are seen, constituting the plumule or first bud of the plant.

Fig. 324.—Embryo of a species of Arrow-grass (*Triglochin Barrelieri*), showing a uniform conical mass, with a slit *s* near the lower part. The cotyledon *c* envelops the young bud, which protrudes at the slit during germination. The radicle is developed from the lower part of the axis *r*.

Fig. 325.—Grain of Wheat (*Triticum*) germinating. The embryo lies at one side of the grain *g*. The radicular portion of the embryo gives off rootlets *r r r r r* covered with cellular hairs. The principal root is the central one; the others being developed subsequently in succession. The roots pass through sheaths *c c c*. The ascending axis *t*, sheathed in the cotyledon, rises upwards.

Fig. 326.—Embryo of *Caryocar butyrosum*. *t*, thick tigelle or caulicule, forming nearly the whole mass, becoming narrowed and curved at its extremity, and applied to the groove *s*. In the figure this narrowed portion is slightly separated from the groove; *c*, two rudimentary cotyledons.

of cellular tissue is seen upon the side of the embryo opposite to the scutellum, that is, on the anterior side. This has been termed the *epiblast*. It is very large in Rice. This by some was considered the rudimentary second cotyledon; but this is impossible, as it arises outside, and after the first cotyledon. It is merely an outgrowth of the radicular extremity like the scutellum. The radicular portion of the axis is usually shorter than the cotyledon, and more dense in structure; but in some instances it becomes much larger, giving rise to what has been called a *macropodous* embryo.

5. *Female Organs and Reproduction in Cryptogams.*

Female organs in higher Cryptogams.

The female organs of reproduction, like the male organs, have not been demonstrated in all Cryptogams. In all vascular Cryptogams, and in Mosses and Hepaticæ, certain usually flask-shaped bodies, which have been termed *archegonia* or *pistillidia* (fig. 327), represent the female organs producing cells or spores, which germinate and form new plants (fig. 54). These archegonia have the general structure of a large cell, the *central cell* or *oosphere* (*c*) surrounded by a layer of smaller cells. From the apex of this oosphere leads a canal, which is bounded by four rows of small cells and constitutes the *neck*, and in it is a large cell full of soft mucilaginous matter, which has been formed from the central cell, and is the *canal cell*. Upon the wall of the oosphere, turned towards the neck, a small portion different from the surrounding part is the *receptive spot*. Fertilization is effected by the antherozoids freed from the antheridium, penetrating the neck of the archegonium, and eventually reaching the receptive spot of the central cell or oosphere; they then enter the oosphere and coalesce with it. The fertilized oosphere is termed an *oospore*, and it then may escape from the archegonium, and sooner or later germinates; or it germinates within the archegonial cells. These archegonia are, in vascular Cryptogams, produced upon a cellular expansion formed generally from a spore, and termed the *prothallus* (fig. 245), which is of varying size and form. Both archegonia and antheridia may be formed on one prothallus, or only one form of organ may be produced, thus indicating a tendency to diclinism.

In Characeæ the female organ has a peculiar structure.

In Characeæ. and is termed a *nucule* (fig. 240, *n*). This consists of a large *central cell*, of which the contents at the apex are clear and hyaline, while the lower part contains much starch and fat. Rising from its base and twisting round it are five long tubes (fig. 328), at the extremity of each of which

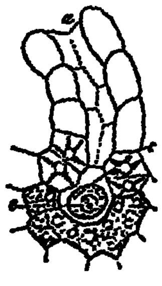

Fig. 327.

Fig. 328.

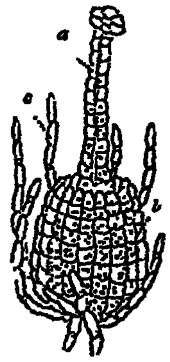

Fig. 329.

FIG. 327.—Archegonium of the Forked Spleenwort (*Asplenium septentrionale*) immediately after fertilization. *a*, canal leading to the large cell (oosphere) *c* at the base of the archegonium; *c*, nucleated embryonic cell, whence the sporangiferous frond proceeds.
FIG. 328.—Nucule of Chara entire, with five cells, wound round a large central cell in a spiral manner; *a*, crown or coronula of five smaller cells.
FIG. 329.—Pistillidium of Liverwort (*Marchantia*). It is a cellular body surrounded by an involucre (perigone or calyx) *b*, and septate filaments (paraphyses) *c*, and it is provided with a styloid calyptra *a*.

above the apex of the central cell is a single short cell in Chara, while in Nitella it is divided transversely into two. These five or ten short cells form the *crown*. They unite together so that their apices project as small teeth. Between the crown and the apex of the central cell, which is termed the *apical papilla*, a cavity is included, bounded at the sides by the five enveloping tubes, which at this point form the *neck* of the nucule. The cavity of the neck is constricted in the middle by the projection inwards of the tubes to form a sort of diaphragm, so that the enclosed cavity has a rude hour-glass-like shape, the upper cavity closed above by the crown being connected by a narrow canal with a lower cavity bounded beneath by the apical papilla of the central cell. When fertilization takes place slits are formed betwixt the five tubes of the neck, beneath the crown and above the diaphragm. The antherozoids from the globule enter by them into the upper cavity, pass through the canal into the lower one, and fuse with the apical papilla of the central cell or oosphere. The oospore thus formed becomes detached from the plant, being covered by the thickened inner wall of the tube which invested it. The nucule rises from the base of one of the whorl leaves in Chara, and is therefore above the globule; in Nitella it is produced upon the leafy axis beneath the globule.

In Mosses and Hepaticæ. In Mosses the archegonia are frequently situated along with the antheridia and paraphyses. They are surrounded by the same whorl of leaves, or *perichætium*, when the moss is said to be hermaphrodite, or they occur separately on the same or on different plants, the moss being then monœcious or diœcious. The term *perigone* is applied to the whorl of leaves around the antheridia. The basal portion of the archegonia which surrounds the oosphere is termed the *epigone*. In Hepaticæ the archegonia (fig. 329) are situated in the substance of the thallus itself, or they may be in various situations, as in Jungermannia (fig. 330); in Marchantia they are produced upon the under surface of a stalked stellate disk (fig. 331).

In Thallogens. In many Thallogens no structure analogous to a female organ has been as yet discovered; in some, however, such structures have been met with. Thus amongst Algæ large cells, termed *oogonia*, are found, in which usually one, sometimes many (Fucaceæ), oospheres are produced (fig. 332). The antherozoids from the antheridium fertilize these, penetrating the oogonia at a definite point thinner than the surrounding portion; and oospores are formed. In the Florideæ, a group of Algæ, *the organs are different* in character. Here the antherozoids are *not motile*, having no cilia. On discharge from the antheridium, these are washed into a long filiform hollow body, termed the *trichogynium*. This is supported usually upon a cellular stalk—the *trichophore*—at the side of the base of which is a small cellular mass. The antherozoids having entered the trichogynium, fertilization is effected, and results in the formation, from the cellular mass at the base of the

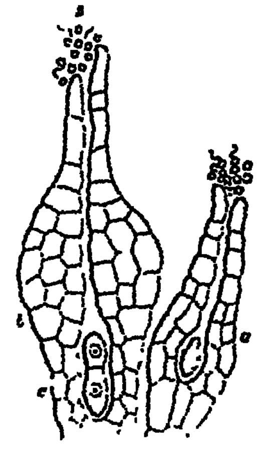

Fig. 330.

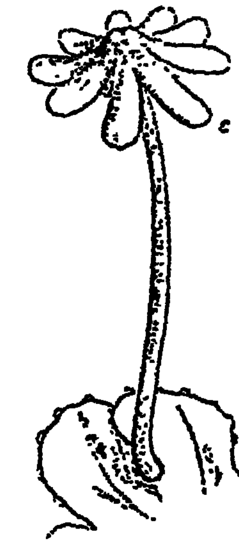

Fig. 331.

FIG. 330.—Archegonia of *Jungermannia bicuspidata*. *a*, archegonium, with a tube leading to a cavity near the base of which is a cell; *b*, archegonium after fertilization, with the cell *c* divided into two nucleated portions. This double nucleated body is the rudiment of the fruit-bearing stalk. At the apex of the canal leading to the cell are seen spermatozoids *s s*.
FIG. 331.—Thallus of Liverwort (*Marchantia polymorpha*), bearing a stalked fruit *s*, which is the product of the impregnated cell of the archegonium. The receptacle at the apex of the stalk bears on its under surface sporangia containing spores and elaters. The spores, when germinating, produce a thallus, on which antheridia and archegonia are formed.

trichophore, of a large cell, the *cystocarp*, in which spores are formed. In the Saprolegnieæ the antheridia actually penetrate into the oogonium and discharge their antherozoids. Amongst Fungi it is rare to find sexual organs. In some thecasporous fungi, as Eurotium, a sexual process has been observed. The female organ, here termed *ascogonium* or *carpogonium*, is of a spiral elongated character, immediately surrounding which are the antheridia,

Fig. 332.

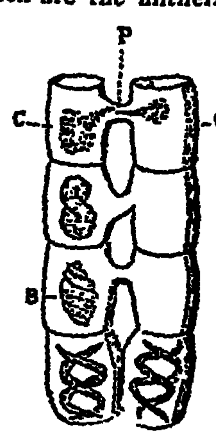

Fig. 333.

FIG. 332.—Transverse section of a conceptacle of a Seaweed (*Fucus vesiculosus*), showing the spores in the coverings, *p*, and paraphyses lining the cavity. The spores escape by an orifice *o*.
FIG. 333.—Two filaments of a Confervaceous Alga (*Zygnema*), conjugating, *i.e.*, uniting together by tubes *p*, which pass between the different cells. The contents of two cells *c c* unite so as to form a germinating spore *s*. In the lower two cells spiral filaments are seen.

few in number, which open into the apex of the female organ, and discharge their antherozoids. The result is the formation of cellular tissue round the ascogonium, forming what is termed a *perithecium*, and within the ascogonium large cells (*asci*) are produced, in which spores

or sporidia are subsequently developed. In Lichens no sexual organs have as yet been clearly demonstrated.

Amongst Fungi and Lichens there are certain bodies to be noted, which may be connected with sexual reproduction, but the function of which is at present unknown. Embedded in the margin of the thallus in Lichens and on various parts of the plant in Fungi, certain hollow urn-shaped bodies are found, which have been termed *spermagones* (conceptacles) (fig. 334). These are usually closed all but a small opening at the apex. From their base rise peg-shaped projections or *sterigmata* (fig. 335), bearing at

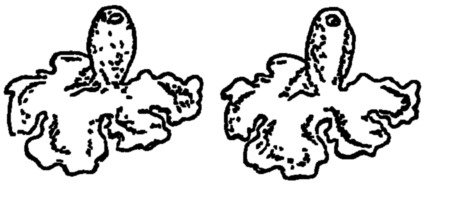

Fig. 334.

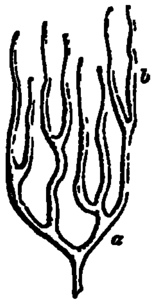

Fig. 335.

FIG. 334.—Two spermagones on thalli of Lichens.
FIG. 335.—Sterigmata *a* and spermatia *b* of *Cladonia fimbriata*.

their summit elongated, sometimes curved, bodies, termed *spermatia*, which, when mature, are discharged through the apex of the spermagone. These are by some considered the analogues of the antherozoids in other Cryptogams. There are also found other conceptacles, to which the name of *pycnidia* or *pycnides* is given. These contain large spores, which have been termed *stylospores* (fig. 336), but their homology is at present unknown.

Another process of reproduction is seen amongst Cryptogams. This is termed *conjugation* (fig. 333). It differs from the process of fertilization just described in that it consists of a union of the contents of two similar cells, whilst fertilization essentially consists in the mutual influence of dissimilar cells. It is well seen in many Algæ, such as Diatoms, Volvocineæ, Conjugatæ, also in some Fungi, such as species of Rhizopus and Zyzygites. It may consist in the coming together of two cells,—either moving spores, as in Pandorinia, or motionless, as in Diatoms,—which completely fuse, and a compound spore, or *zygospore*, results; or prolongations of the wall of two adjacent cells meet, the partition between the two gives way and the contents from the one pass into the other, and a zygospore is formed, as in Zygnema. Zygospores germinate only after a long period of rest.

Amongst Thallogens especially, though it also occurs in other Cryptogams, the asexual mode of reproduction is very common. But the manner of formation and the nature of the spores is diversified.

Amongst Algæ two modes of asexual reproduction are seen,—by motile spores and by motionless or resting spores. In the former case the contents of a cell form a new cell, which escapes from the mother-cell, and moves about by means of cilia, which are formed either all round it, as in Vaucheria (fig. 337), or as a tuft at one end, as in Œdogonium. These are termed *swarm spores*, or *zoospores*, and frequently are of different sizes, being termed respectively *microgonidia* and *macrogonidia*. After swimming about for a time they fix themselves, and develop small rhizoids from one extremity, the other growing up into the plant. The motionless spores are seen in the Florideæ, where they are formed in cells, four in each, attached together in a row, or as a tetrahedron, constituting the *tetraspore* (fig. 338).

Amongst Fungi asexual reproduction is very common. Swarm spores are rarely formed; but the mode of formation of motionless spores is very various. They may be produced in the interior of distinct sacs called

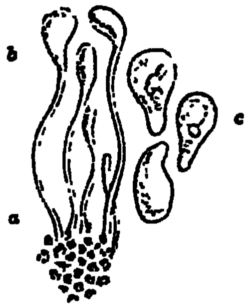

Fig. 336.

Fig. 337.

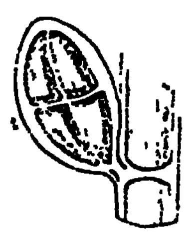

Fig. 338.

FIG. 336.—Basidia *a*, stylospores *b*, free stylospores *c*, from pycnides of Lecidia.
FIG. 337.—Zoospore of an Alga (*Vaucheria*), surrounded by moving cilia.
FIG. 338.—Tetraspore *t* of one of the rose-coloured Seaweeds (*Callithamnion cruciatum*).

thecæ, *asci*, or *cystidia* (fig. 339), when they are denominated *endospores* or *ascospores*, and the plants are said to be *thecasporous* or *ascosporous*. When they are developed on the exterior of sacs called *basidia* (fig. 340), they are denominated *exospores*, and the plants are *basidiosporous*.

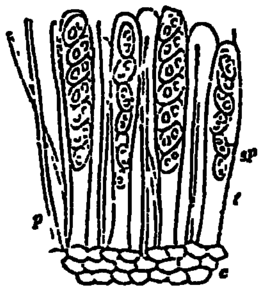

Fig. 339.

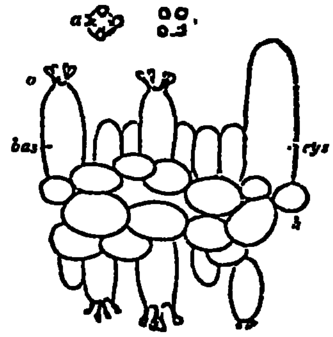

Fig. 340.

FIG. 339.—Vertical section of the fructification of a Fungus (*Peziza*), showing cellules *c*, bearing clavate spore-cases or thecæ *t*, which contain nucleated cells *sp*. These cells become sporidia, containing spores. Along with the thecæ are cellular filaments or paraphyses.
FIG. 340.—Portion of a lamella or gill of the Mushroom (*Agaricus campestris*), cut transversely, showing the two lateral surfaces bearing basidia *bas*, with four spores *spo* at their apices, and cystidia *cys* or sacs containing minute cells. The hymenium is marked *h*. At *a* and *b* are represented the four spores.

When produced in the midst of a gelatinous mass, without any evident differentiation, they are called *myxospores*, the plants being *myxosporous*. Both the endospores and the exospores may by division become *septate*, and form *compound spores*, each of the secondary spores so formed being termed a *merispore*. Four or eight basidiospores are usually produced from each basidium. In the asci numerous spores are formed. Other forms of spores seen in Fungi are the *conidia*. These are stalked spores which arise from a mycelium.

In Lichens we find asci which produce spores or sporidia just as in Fungi; and in addition there also exist spermogones with their sterigmata and spermatia as well as pycnides and stylospores. Besides the spores there are organs called *soredia* in Lichens. These are groups of small round cells or *gonidia* (fig. 97), surrounded by hyphæ, which are capable of independent growth after removal from the thallus. These gonidia are now regarded by many as an Alga, upon which the hypha, which is supposed to be an ascomycetous Fungus, is parasitic.

In Chara a curious mode of asexual reproduction is seen which presents several well-marked modifications, the process always proceeding at the nodes, and consisting in the growth of a new axis from a nodal cell either isolated or united with other cells.

In all vascular Cryptogams, Muscineæ, and many Thallo
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or
is

In Ferns. Amongst Ferns the oospore germinates and produces an asexual generation. The embryo plant formed from this spore is a simple mass of cellular tissue, no cotyledons being formed. This, then, is an *Acotyledonous* embryo (fig. 54). The same happens in other vascular Cryptogams, which are therefore also Acotyledonous. The embryo so formed has a primary meristem, with an apical cell, by division of which it increases in size,—roots being formed downwards and a leaf-bearing axis upwards, upon which, eventually, the *fructification* (fig. 341) is formed. This consists in Ferns of the production of either stalked or sessile spore-cases or *sporangia*, from the epidermis on the back (Aspidium) or edges (Pteris) of a leaf (frond), or upon a special branching axis (Osmunda), or a spicate one (Ophioglossum). These, when situated on the frond, are arranged in definite clusters or *sori* (fig. 342), either

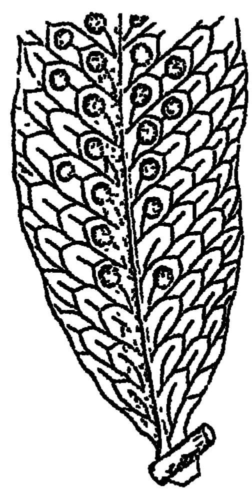


Fig. 341.

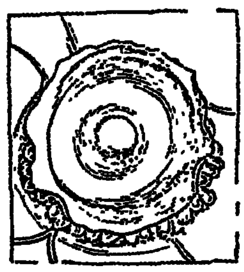


Fig. 342.

FIG. 341.—Frond (fructiferous leaf) of a Fern (*Niphobolus*), showing sori, or round clusters of sporangia at the ends of veins. As these sori are on the back of the frond, the Fern is called dorsiferous.

FIG. 342.—Sorus or cluster of sporangia of a Fern (*Aspidium trifoliatum*). The sporangia are covered by an indusium or involucre, derived from the epidermis of the frond. The involucre is round (orbicular), and attached by its centre in an umbilical manner. The annulate sporangia are seen at the lower edge of the involucre.

rounded or elongated. With the sporangia are usually associated jointed cells or *paraphyses*. Frequently the sori are covered by a thin cellular layer forming an *indusium* or involucre, or the margin of the frond folds over them, forming a false indusium. Within the sporangium spores are produced, and when ripe these escape by the rupture of the sporangium, this in many cases being provided for by the formation, at a definite point, of an *annulus* or ring (fig. 343) of unequally thickened cells. Hence some Ferns are *annulate*, others *exannulate*. The cell-wall of each spore is divisible into an outer layer or *exospore*, and an inner or *endospore*. When the spore reaches the soil it germinates, and after a longer or shorter period produces the sexual generation. In this process the variously marked exospore is ruptured by the enlarging endospore, which divides so as eventually to form a flattened cellular expansion or *prothallus* (fig. 344) with small cellular *rhizoids*. Upon this, usually on the under surface, the sexual organs, consisting of antheridia and archegonia, are produced. A tendency to *diœcism* is observed in prothalli, frequently producing only one kind of sexual organs. By the mutual influence of those sexual organs an oospore is formed, from which a new asexual generation arises. Thus in Ferns the alternation consists of two dissimilar generations,—a sexual or prothallial generation, and an asexual generation.

In Equisetaceæ. In Equisetaceæ the same alternation of two dissimilar generations occurs. Upon an asexual generation the fructification is formed at the apex of a leaf-bearing axis. Peltate hexagonal stalked scales (fig. 345) are arranged in close whorls round the apex of the axis, forming a pyramidal head (fig. 346, *f*), the surface of the scales being

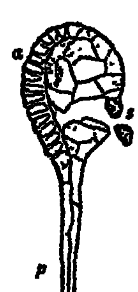


Fig. 343.

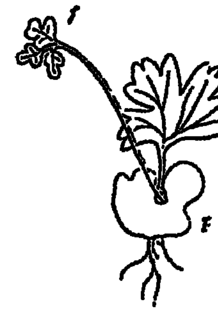


Fig. 344.

Fig. 345.

FIG. 343.—Mature sporangium of the Male Fern (*Lastrea Filix-mas*). It is supported on a stalk *p*, some of the cells of which form an elastic ring or annulus *a* round the spore-case. The spore-case *s* opens at the side to discharge the spores.

FIG. 344.—Young plant of a Fern (*Pteris paleacea*), showing the commencement of the sporangiferous frond *f*, arising from the impregnated ovule in the archegonium, the prothallium *p* being still attached.

FIG. 345.—Polygonal scale *s* of a species of Horse tail (*Equisetum*), bearing membranous sacs *t*, which open on their inner surface to discharge spores.

directed tangentially to the axis. Round the margin of the inner surface of these scales the sporangia are produced projecting towards the axis. When ripe each sporangium

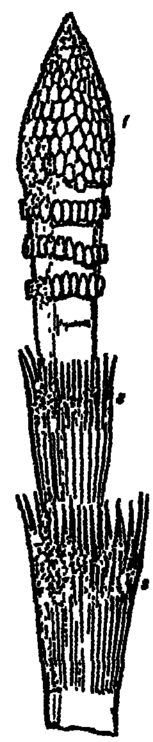


Fig. 346.

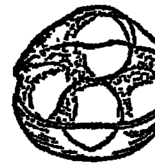


Fig. 347.

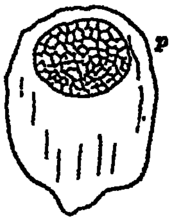


Fig. 348.

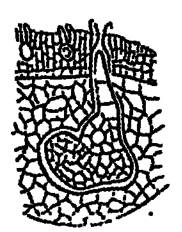


Fig. 349.

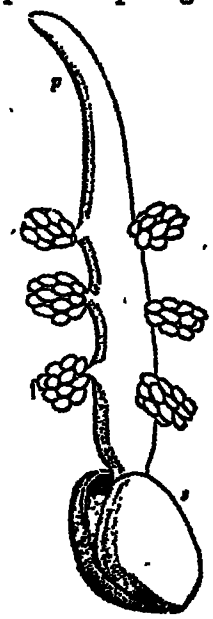


Fig. 350.

Fig. 351.

FIG. 346.—Fructification of a species of Horse-tail (*Equisetum maximum*). The stalk is surrounded by a series of membranous sheaths *s s*, which are fringed by numerous sharp processes or teeth. The fructification *f* is at the extremity of the frond, in the form of a pyramidal mass of polygonal scales, bearing spores on their under-surface.

FIG. 347.—Large spores of Club Moss (*Lycopodium*) enclosed in an involucre. It is sometimes called an oophoridium in consequence of containing germinating bodies (ovules). It represents the female organ. The involucre opens transversely to discharge the spores (macrospores).

FIG. 348.—Macrospore discharged from the oophoridium of a Lycopod (*Selaginella Mertensii*), with the outer coat removed to show the young cellular prothallium *p* at the upper end.

FIG. 349.—Vertical section of a small portion of the prothallium and upper part of the large spore of a Lycopod (*Selaginella denticulata*), showing the embryo *e*, developed from a central cell of one of the archegonia *a*, carried down by the growth of the suspensor, so as to be embedded in the cellular tissue at the upper part of the spore.

FIG. 350.—Fructification of a species of Pepperwort (*Marsilea Fabri*). The sporocarp *s* opens to give out a peculiar cellular cord or peduncle *p*, which at first was curved in a ring like manner. This cord bears spike-like fructification *f*, consisting of antheridia and pistillidia enclosed in sacs.

FIG. 351.—Archegonium *a* of a Rhizocarp (*Pilularia globulifera*) cut vertically after impregnation, showing the prothallium, with the embryo in its interior in an advanced state. This embryo gives origin to the leafy stem.

opens towards the stalk of the scale, and the spores are shed, each having attached to it four clavate filaments sometimes

termed *elaters* (fig. 3), which are very hygroscopic. By germination of these spores a sexual generation or prothallus is formed.

opo-. In Lycopodiaceæ a sexual process has not been observed in all genera; but in Selaginella and Isoetes, where it has been observed, it is exceedingly instructive, as it forms a connecting link between the process as seen in Cryptogams and that observed in Angiosperms. The asexual generation produces the fructification which consists in the formation of a single sporangium in the axil of each leaf of a certain part of the axis. In those genera in which sexual organs have been discovered these sporangia are of two sizes, termed *macrosporangia* (fig. 347) and *microsporangia* respectively. The whole fructification frequently forms a spike. In the *macrosporangium* or *oophoridium* few, usually four, large spores (*macrospores*) are formed, having each an exospore and an endospore. In the microsporangium (fig. 248) numerous small spores or microspores are formed of a similar structure. When the sporangia are shed the capsule decays, and the spores escape. Within the endospore of the macrospore, a development of cellular tissue takes place which eventually completely fills it and constitutes the *prothallus*, termed sometimes on this account *endothallus* (fig. 348). As it increases in size the exospore is ruptured triradiately, and the endospore projecting is also ruptured, and thus the prothallus is protruded, in the substance of which archegonia are formed. The microspores, on the other hand, produce within their endospore, sometimes after the formation of a rudimentary prothallus, antherozoid mother-cells, which are discharged by the rupture of the exospore and endospore (fig. 249). By fertilization of the oosphere of the archegonium an oospore is formed, from which the sexual generation arises. The embryo is formed from the lower part of the oospore, the upper half elongates and forms a *suspensor* (fig. 349) of several cells, by which the embryo is pushed downwards into the substance of the prothallium, and there develops into a young plant, rudimentary cotyledons being formed upon the young axis. It will be observed that this process resembles very much the mode of embryogeny in Phanerogams, and, indeed, from this it is but a step to the form found in Gymnosperms and thence to Phanerogams.

In Rhizocarpeæ. In Rhizocarps the sporangia are formed in the interior of ovoid sacs, termed *sporocarps* (fig. 350), which are usually supported on stalks, and rise from the leaves near their base, one or many on the same stalk. In each sporocarp, microsporangia and macrosporangia are formed in various positions; and a prothallium (fig. 351) is formed in the macrospore, as in Lycopodiaceæ. From the oospores formed in it the embryos are produced, but without suspensors.

In Characeæ. In Characeæ there is an alternation of a sexual with an asexual condition. From the oospore a small proembryo is first formed, from a cell of which the sexual plant is developed.

In Mosses. In Mosses the sexual generations are produced as lateral shoots from a filamentous *proembryo* or *protonema* (fig. 352). Upon this leaf-bearing axis either at the apex (acrocarpous) or laterally (pleurocarpous) the sexual organs arise. The asexual generation rises from the oospore and constitutes what is usually termed the *fruit* (fig. 353) of the moss. It has been designated the *sporogonium*. The sporogonium is formed by the enlargement of the oospore into an ovoid embryo which presses against the epigone, finally rupturing it, and carries the upper portion upwards with it as the *calyptra* or cap, the lower portion forming a sheath or *vaginula* at the base. This calyptra may be either split on one side, *dimidiate*, or entire, then termed *mitriform*. The upper part of the sporogonium forms a *capsule*, *urn*, or *theca*; the lower portion acts as a supporting stalk or *seta*, which is often swollen, just beneath the capsule forming the *apophysis* (fig. 354, *a*). In Sphagnum the sporogonium is fully developed within the epigonal leaves, and when complete the axis beneath it elongates, forming the *pseudopodium*, and projects considerably beyond the perichætium. The walls of the capsule of the sporogonium consist of several layers of cells. It has a central axis or *columella*, surrounding which are the *spores*. When mature the capsule usually dehisces,

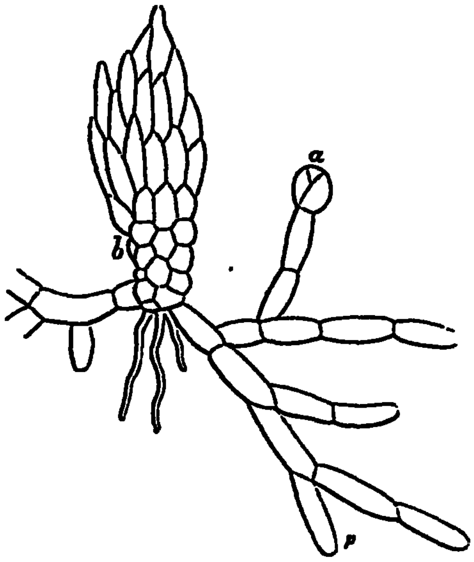


Fig. 352.

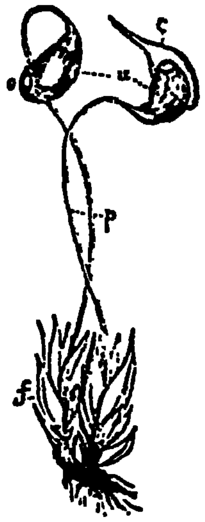


Fig. 353.

FIG. 352.—Moss (*Funaria hygrometrica*), showing the cellular protonema *p*, or proembryo, with its roots *r*, and buds *a*, *b*, whence arise leafy stems bearing the organs of reproduction.

FIG. 353.—Hygrometric Cord-Moss (*Funaria hygrometrica*), with its urn-like thecæ *u* supported on stalks *p*, which arise from perichætial leaves *f*. The thecæ are covered by a calyptra *c*, which splits on one side. The opercular or lid *o* is seen in one of the thecæ from which the calyptra has fallen. The seta is twisted, and displays hygrometric properties.

either by four longitudinal valves, as in Andræa, or most commonly by a lid or *operculum* (fig. 355), between which and the capsule an *annulus* or ring of cells is separated. On removal of the operculum the stoma or opening of the capsule is seen. The margin of this is sometimes entire (*gymnostomi*), more usually fringed with *teeth* or cellular prolongations, constituting a *peristome* (fig. 355, *p*), either in one row (*aploperistomi*) or in two rows (*diploperistomi*). Stretching across the mouth of the capsule is frequently seen a thin cellular membrane, the *epiphragm* or

Fig. 354.

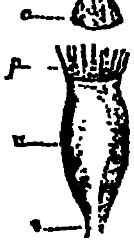


Fig. 355.

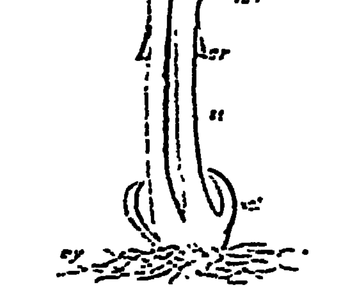


Fig. 356.

FIG. 354.—Fruct [illegible] of the Hair-Moss (*Polytrichum*), consisting of an urn-like (urceolate) case or theca *a*, supported on a stalk (seta) *s*, and covered by a calyptra *c*, which [illegible]

FIG. 355.—Theca *u* of the Extinguisher-Moss (*Encalypta*), showing the teeth of the peristome *p*, which fold inwards [illegible]

FIG. 356.—Vertical section of a Mushroom (*Agaricus* [illegible]) [illegible] hymenium *h*; *p*, the pileus.

tympanum, as in Polytrichum. The spores shed from the capsule germinate and give rise to the proembryo which by budding gives off the sexual plants.

In Hep-. In Hepaticæ the sexual generation arises either directly [illegible]

from the spore of the asexual generation, or a small pro-embryo is first formed. The *sporogonium* is of various forms, and originates differently in different groups from the oospore. It is always formed within a cellular covering or epigone. In Anthoceros the sporogonia are elongated and open by two valves, and there is a central cellular columella. In Jungermannia the sporogonia are globular, and open by four spreading valves. There is no central column, but the inner wall displays cellules, called *elaters*, fixed by one extremity, and containing one or two spiral fibres which by their elasticity scatter the spores. In Riccia the sporogonia are globular, and there are neither elaters nor columella.

In Fungi. Very little is known of the sexual reproduction of Fungi, and regarding the alternation of sexual and asexual generations in them. But we have abundant instances of alternation amongst the asexual generations, and along with this of that curious phenomenon included under the term *heterœcism*, which consists in the growth of one generation of a parasitic Fungus upon one host, and the development of another generation upon a different host. By tracing out this phenomenon, many forms, described formerly as distinct species, are now shown to be generations of one and the same Fungus. The asexual spores of Fungi are produced upon certain structures which have been frequently termed the *fructification*. For instance, in basidiosporous Fungi the collection of basidia forming the *hymenium* is usually situated on large receptacles. The structure commonly known as a *fungus* (fig. 356) is a receptacle produced upon a *mycelium* (*my*). In its young state it appears as a tubercle upon the mycelium covered by a *volva* (fig. 356, *vol*), or wrapper, which it bursts during growth. It consists of a *pileus* or cap (*p*), at the extremity of a stalk, the *stipe* (*st*). On the under surface of the pileus are the *lamellæ* (*la*) or *gills*, of various forms, which constitute the hymenial (*hy*) layer, to which the spores are attached. At first the hymenium is covered by a veil or *indusium*, which during the growth of the stipe is ruptured, the base remaining on the stipe as the *annulus* (*an*) or ring. When, as in the Mushroom, the hymenium is exposed, the fungus is said to be *gymnocarpous* (fig. 356). In other cases, as in Phalloideæ, it is covered over by a *peridium*, and the whole mass so enclosed is the *gleba*, and the fungus is *angiocarpous* (fig. 357). In ascosporous Fungi, as Sphæria, the asci are usually formed within small roundish receptacles, termed *perithecia*; and along with the asci are usually numerous abortive filaments or paraphyses. Sometimes these perithecia are situated upon cushions or branching masses of tissue, the *stroma*. In the myxosporous Fungi the *plasmodium*, or whole protoplasmic mass of the plant, forms receptacles, in each of which is a *capillitium*, or network of fine filaments, in the interstices of which are numerous spores.

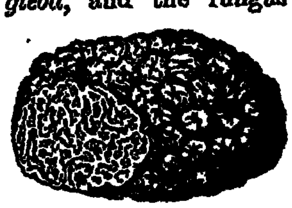


Fig. 357.

The Truffle (*Tuber cibarium*), a subterranean Fungus, with a black tuberculated or warty external covering, and a white cellular interior containing sporiferous cells.

In Lichens spores are formed in asci, which are arranged along with paraphyses, forming a hymenium in receptacles situated on the thallus, and termed *apothecia* or *lirellæ*, which are sometimes (fig. 95) supported on a stalk or *podetium*. The hyphæ, from which the asci arise, form a layer immediately beneath the hymenium, termed the *subhymenial* layer, the thick mass of hyphæ beneath being the *hypothecium*. The outermost layer of the tissue of the apothecium is termed the *excipulum*. In Lich.

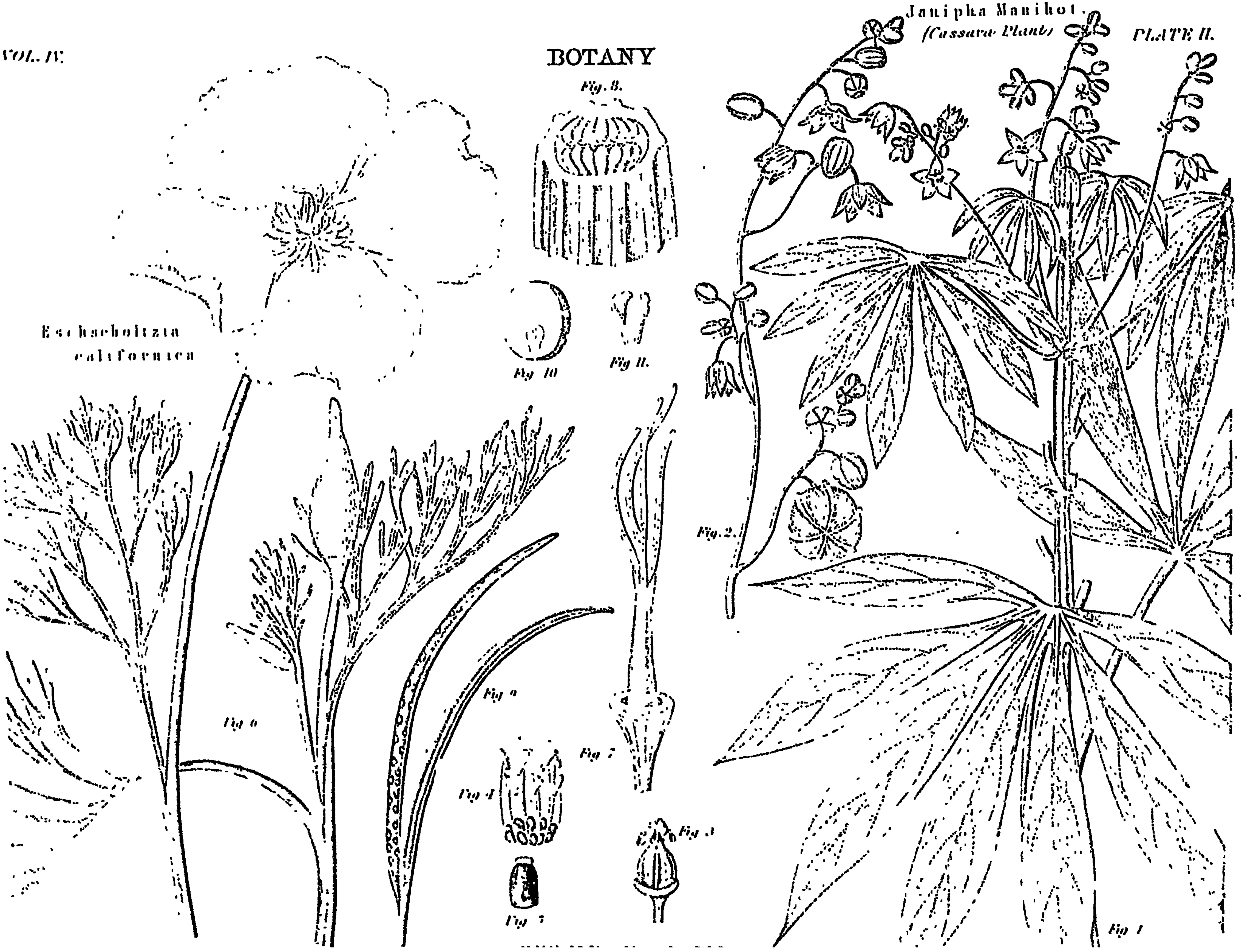
Amongst Algæ alternation of generations is very common; and here, as in the case of Fungi, it may pass through several generations before reaching the original form. This is well seen in Diatoms, also in Œdogonieæ, where three generations are passed through, and in Coleochæte, where there are four dissimilar generations,—sexual and various forms of asexual reproduction alternating. In Algæ.

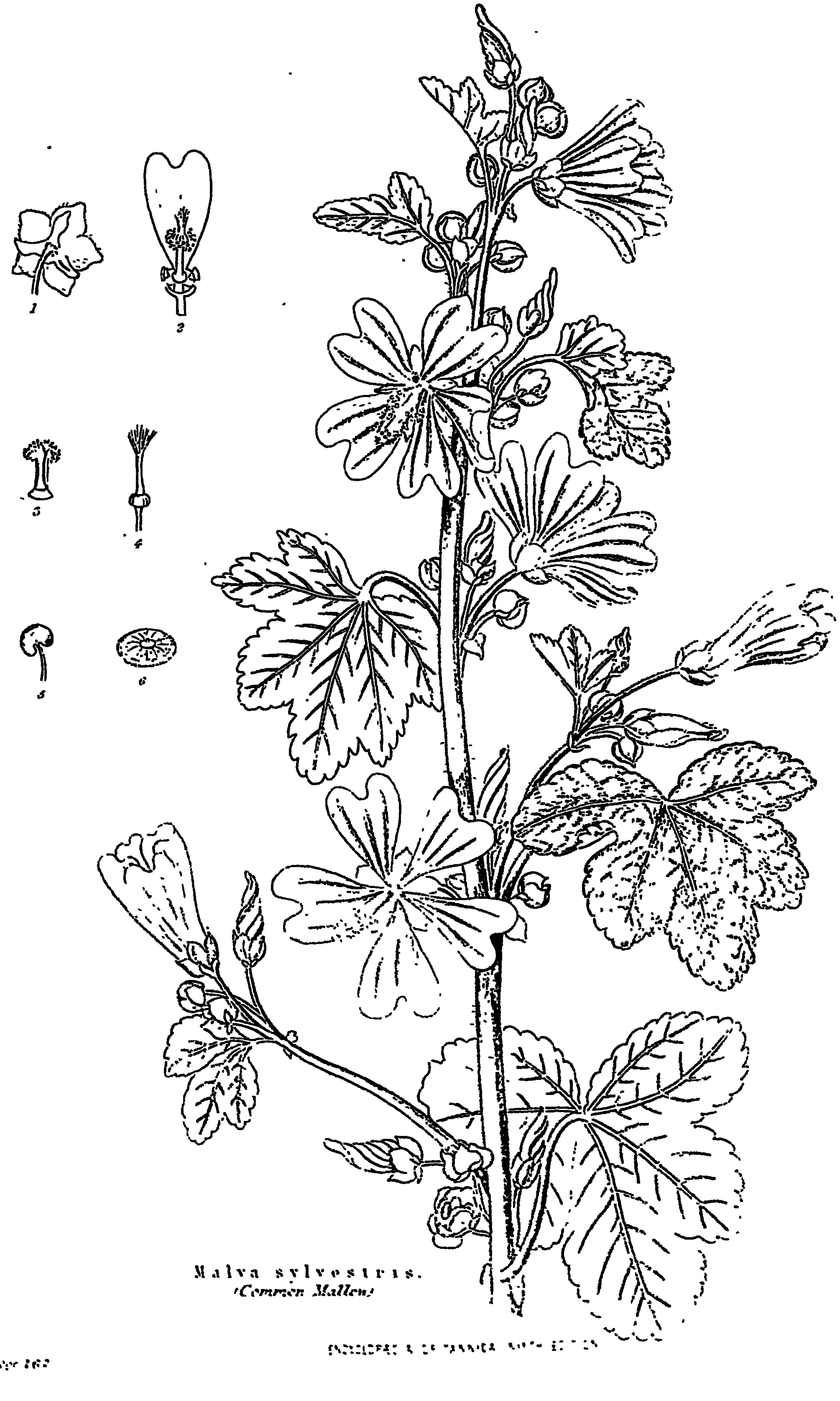
(J. H. B.)

INDEX OF PRINCIPAL SUBJECTS.

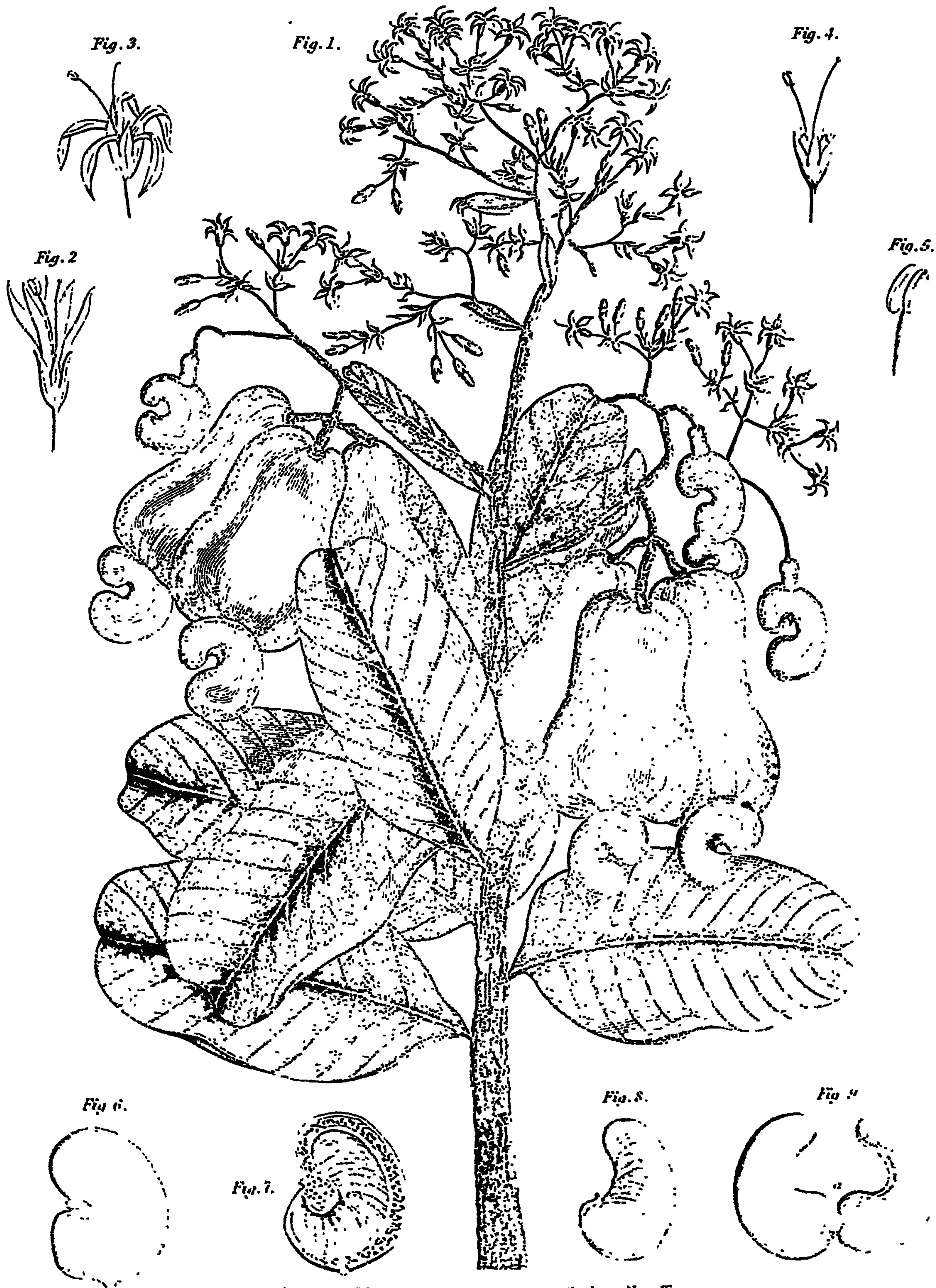
Papaver Rhœas
(Common Red Poppy)

BOTANY

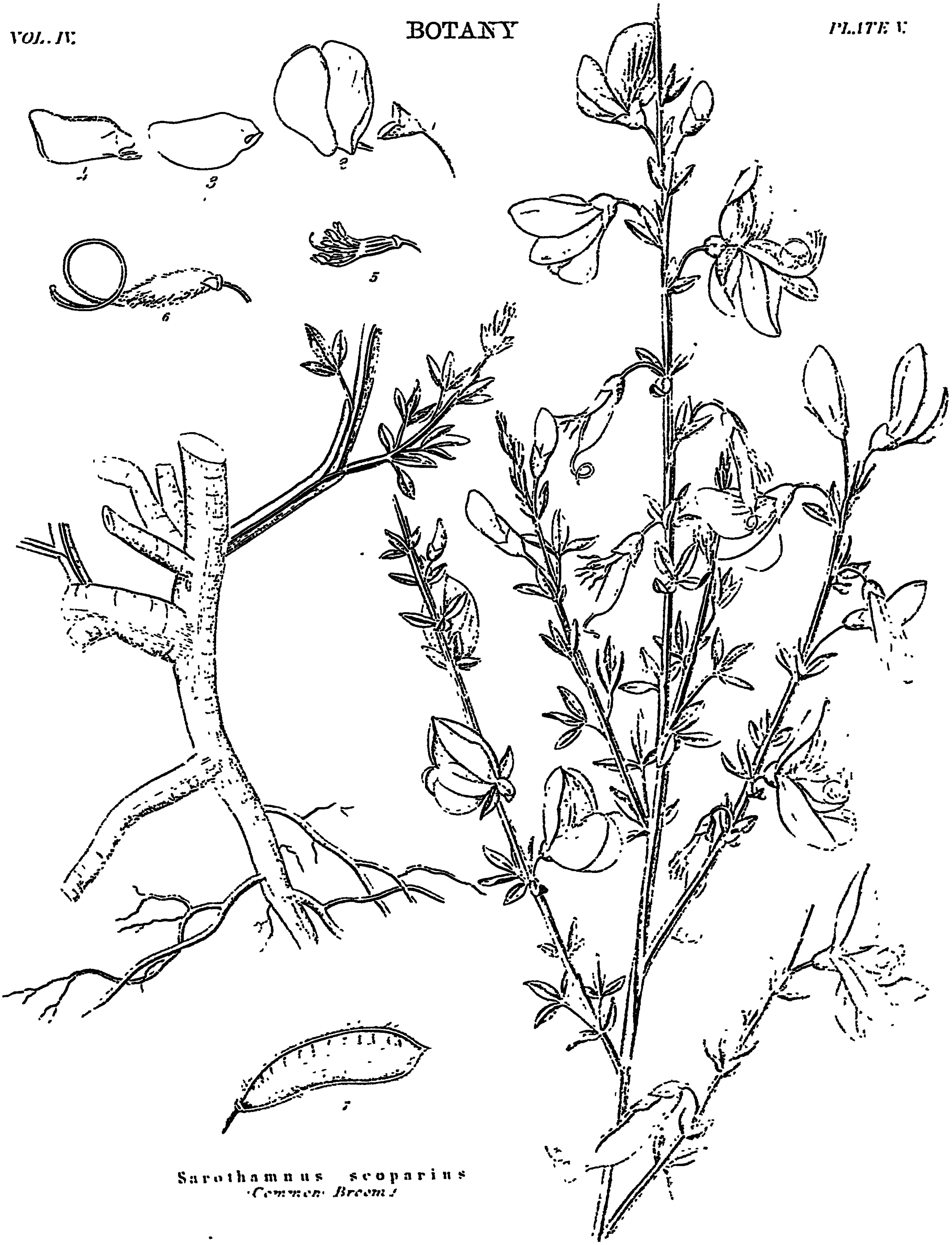

Eschscholtzia
californica
Janipha Manihot.
(Cassava Plant)
Fig. 1
Fig. 2.
Fig. 3
Fig. 4
Fig. 5
Fig. 6
Fig. 7
Fig. 8.
Fig. 9
Fig. 10
Fig. 11.



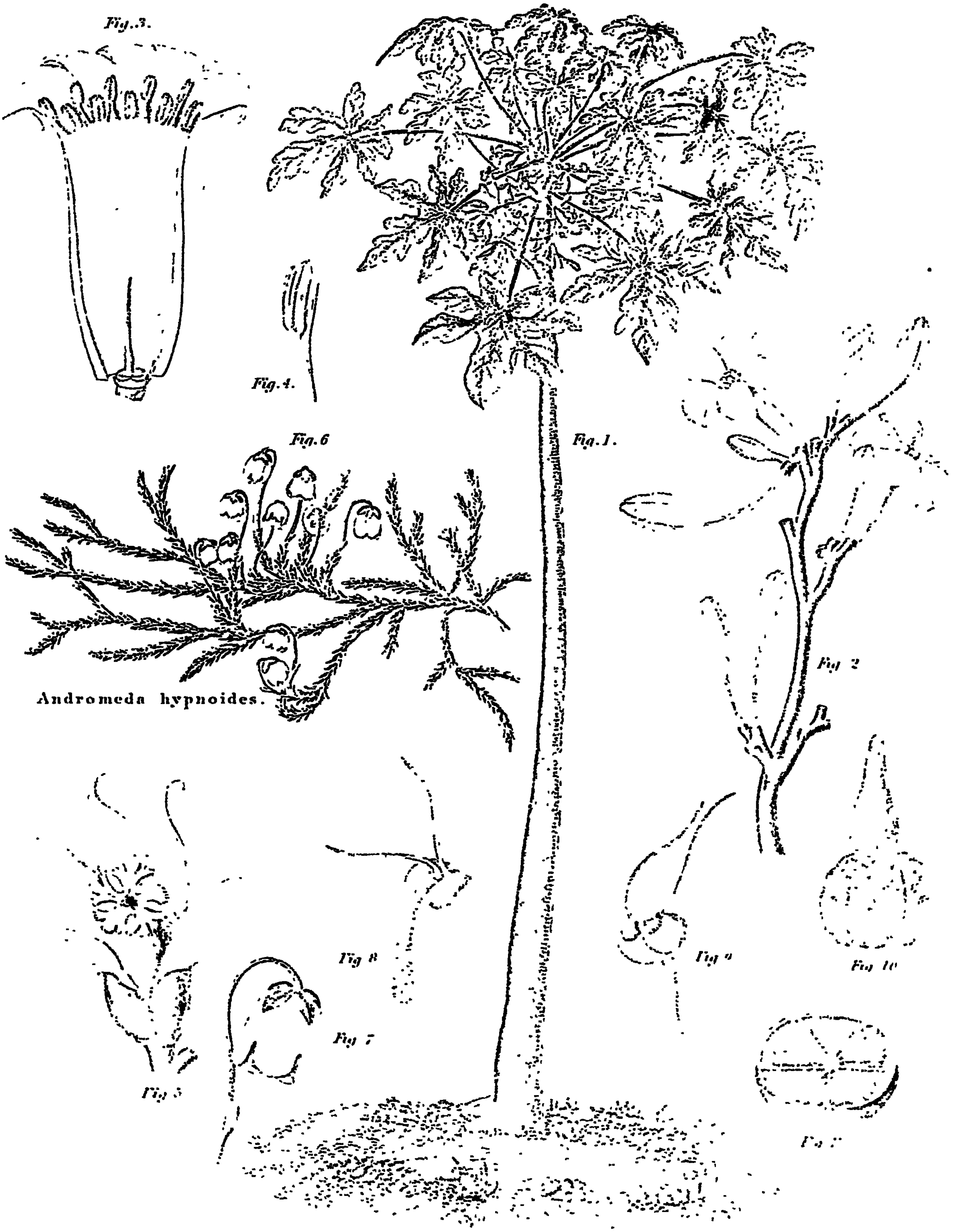
Malva sylvestris.
(Common Mallow)



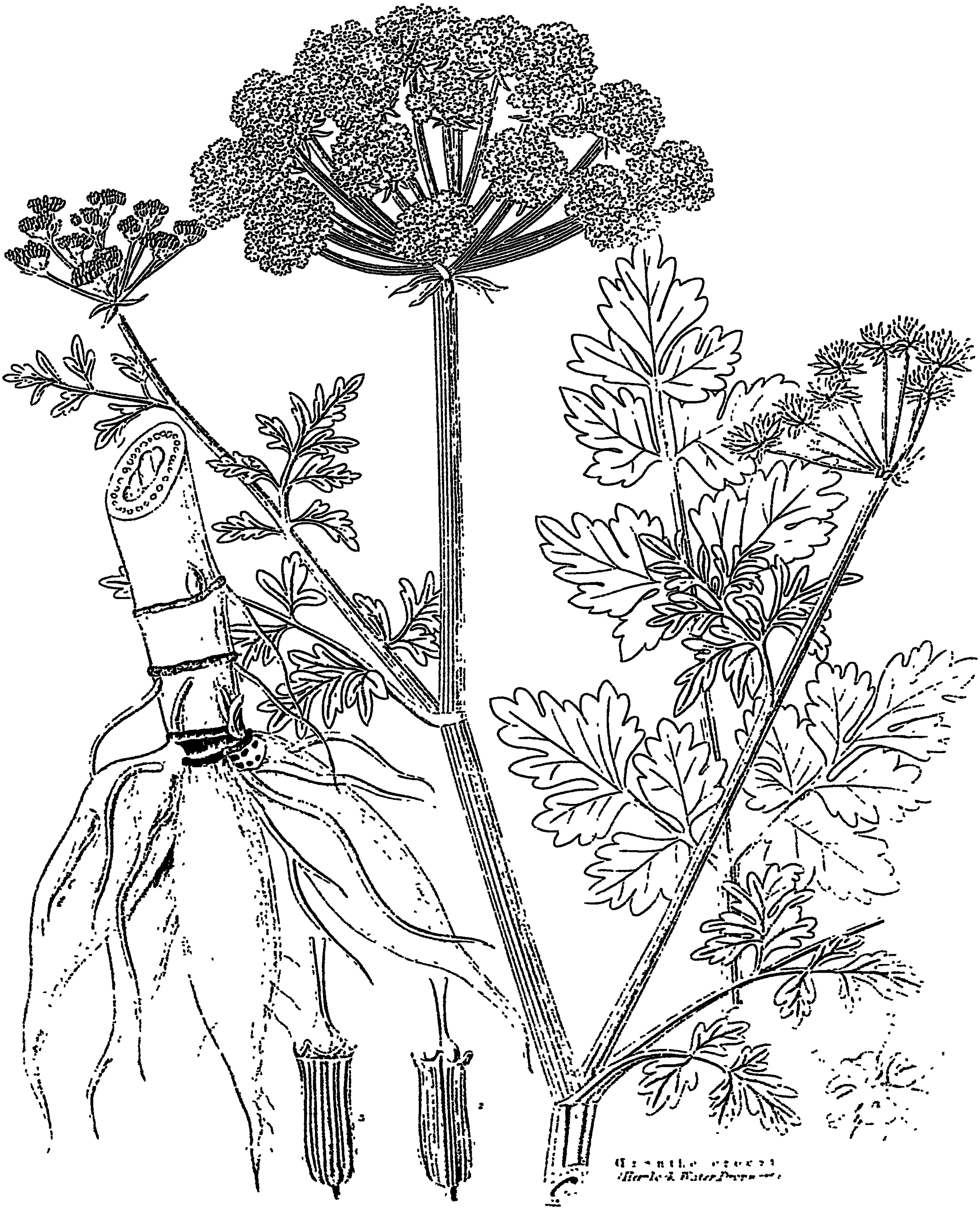
Anacardium occidentale (Cashew Nut Tree)



Sarothamnus scoparius
(Common Broom.)

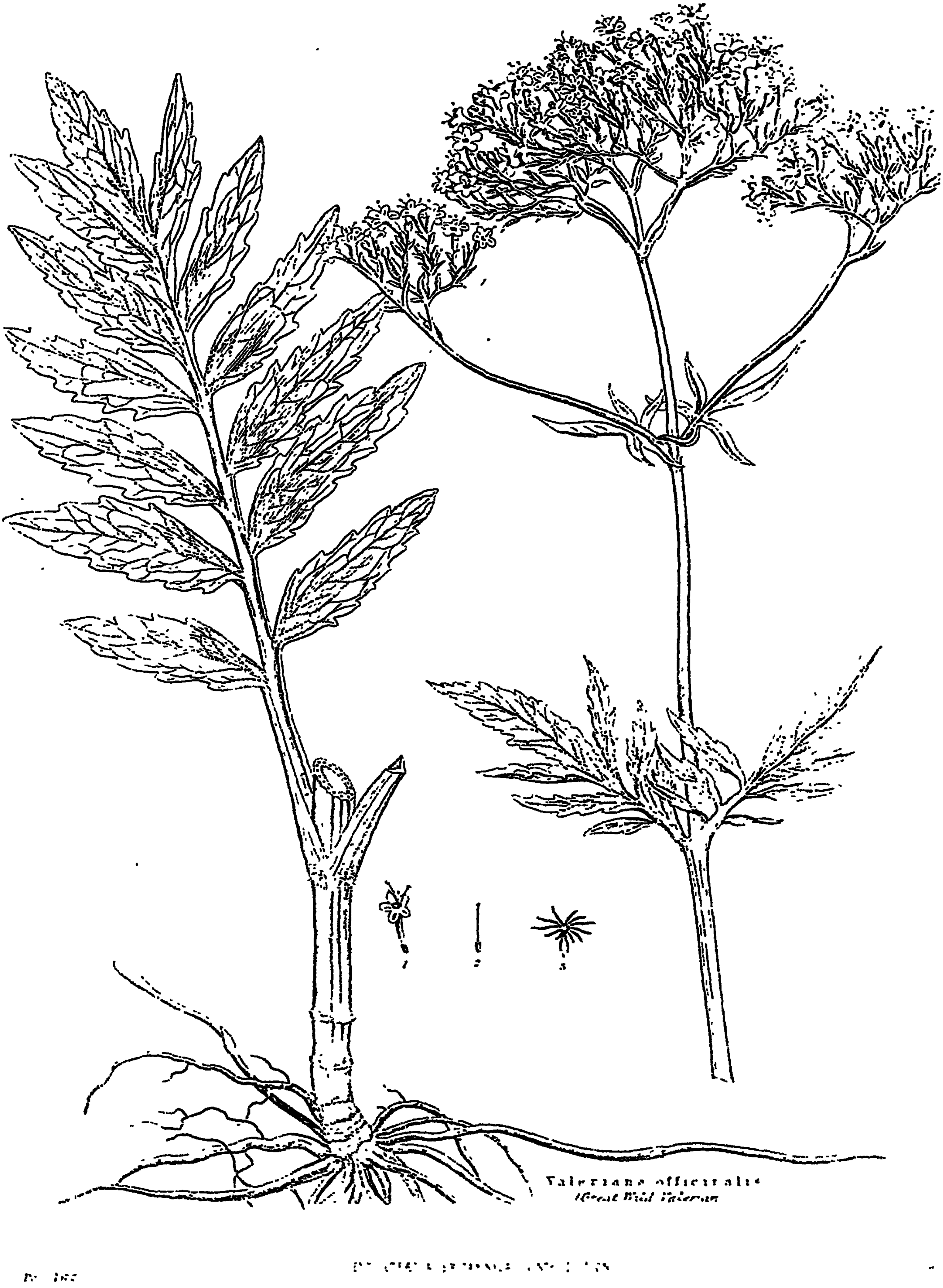


Carica Papaya. *Papaw Tree.*



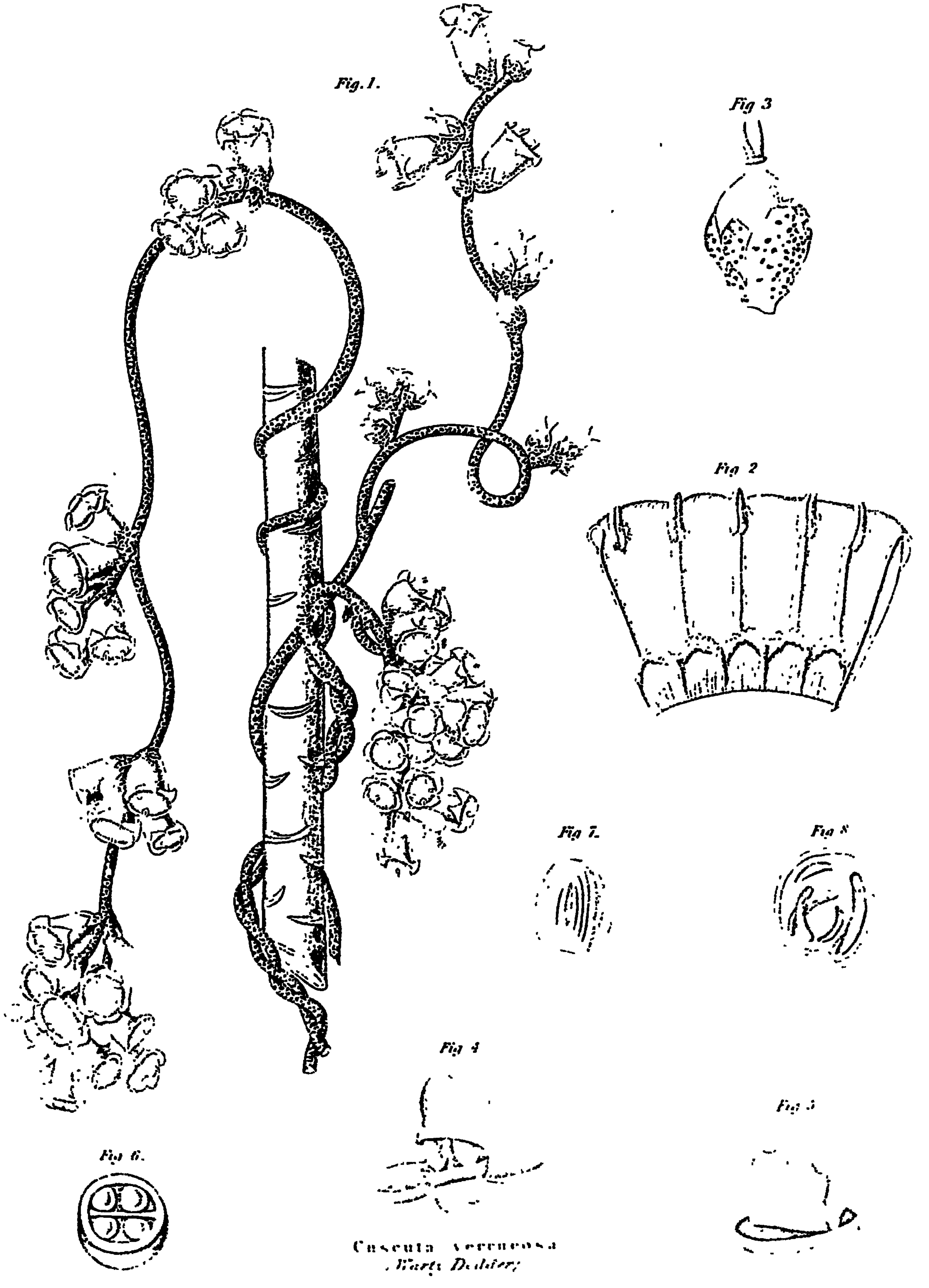
Oenanthe crocata
(Hemlock Water Dropwort.)

[illegible]

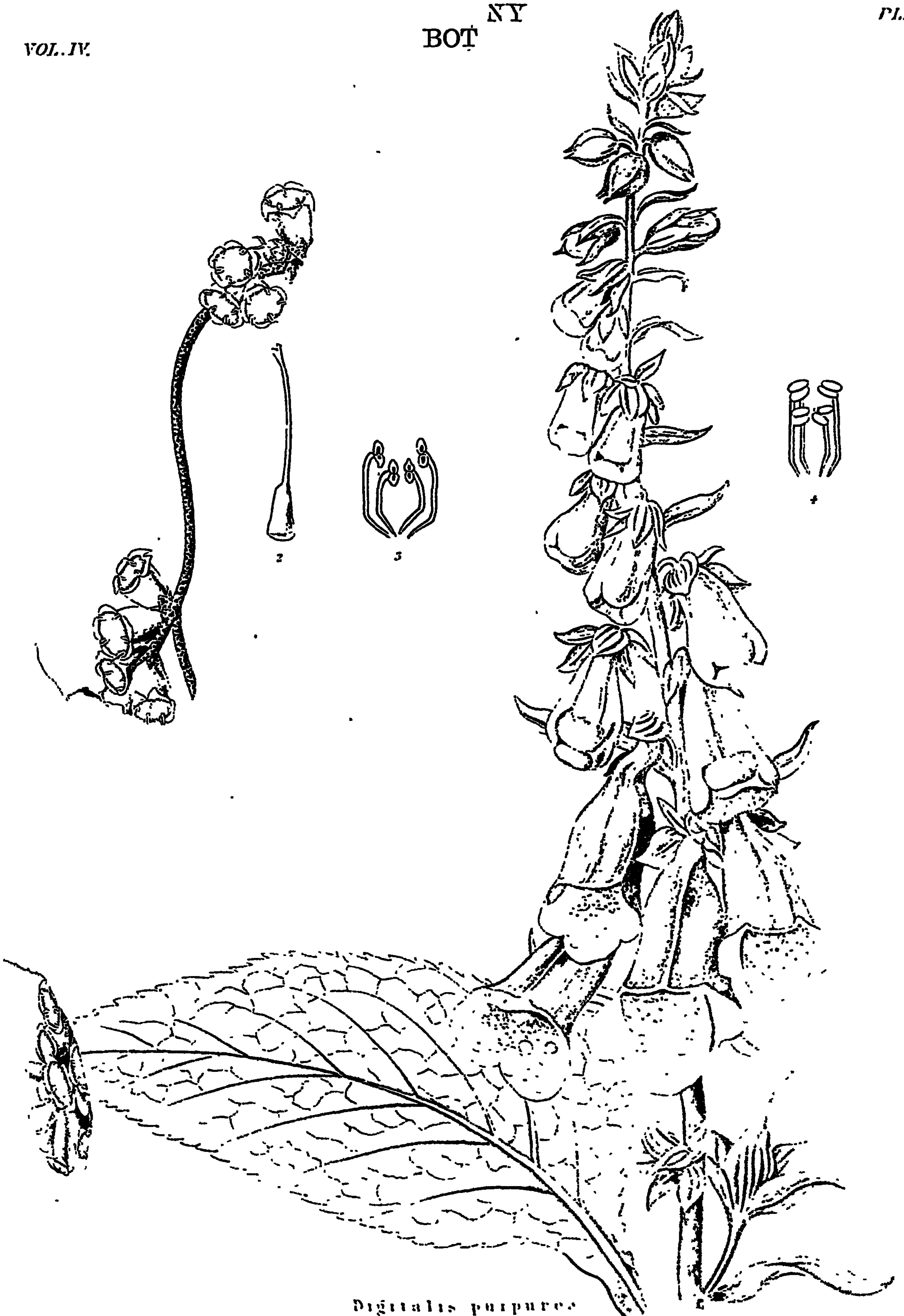


Valeriana officinalis
(Great Wild Valerian


1
Leontodon Taraxacum
Common Dandelion

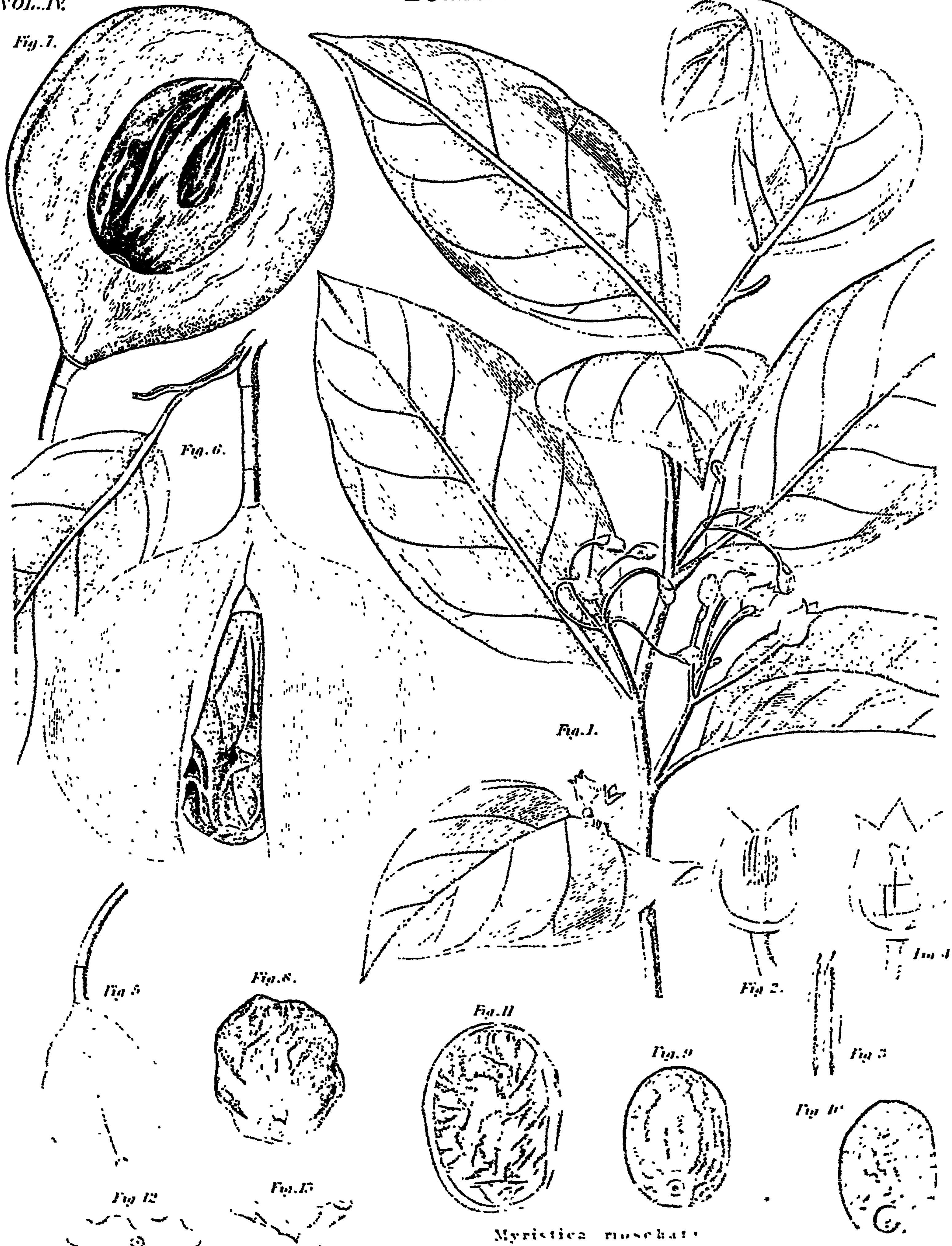


Cuscuta verrucosa
(Warty Dodder)

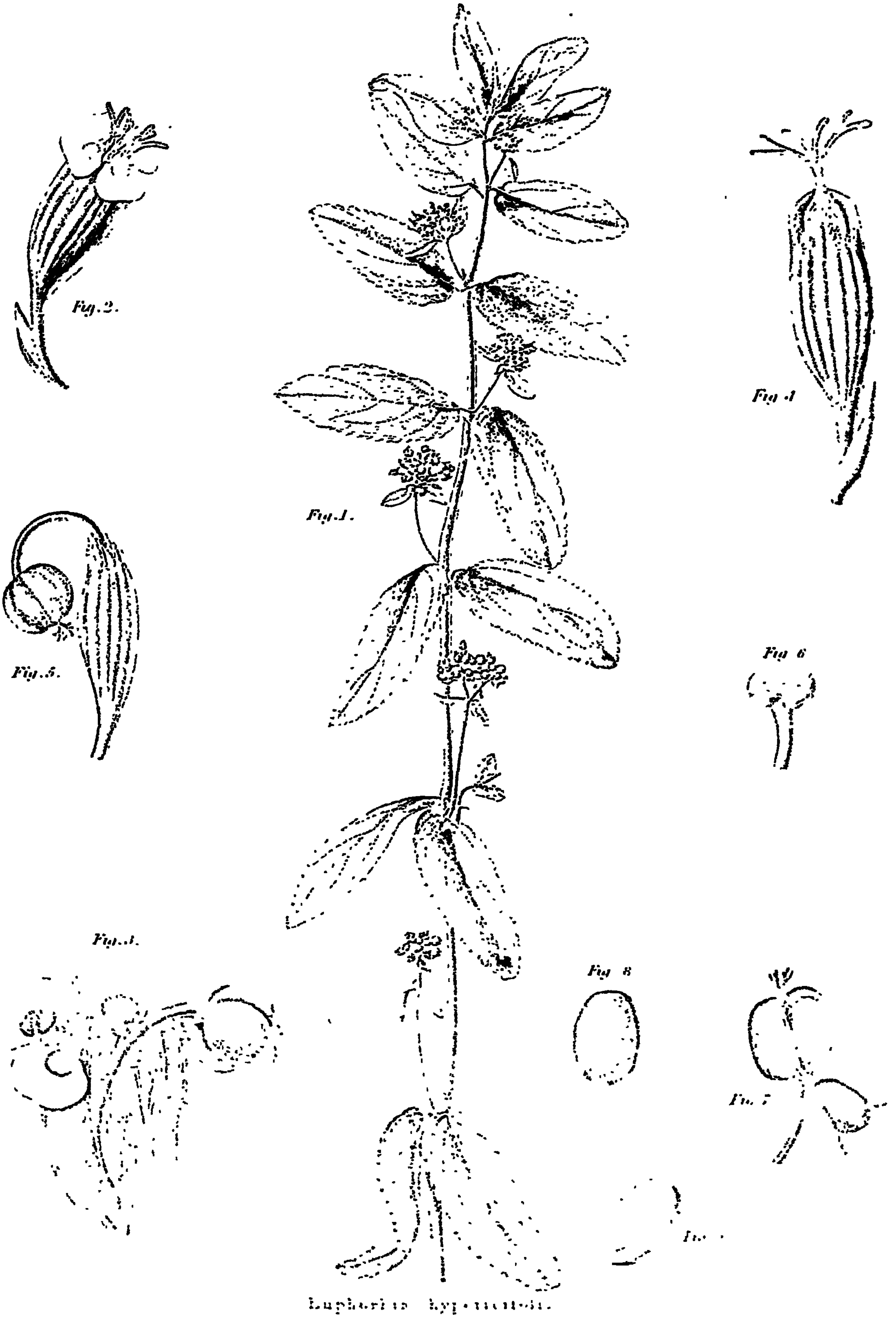


Digitalis purpurea

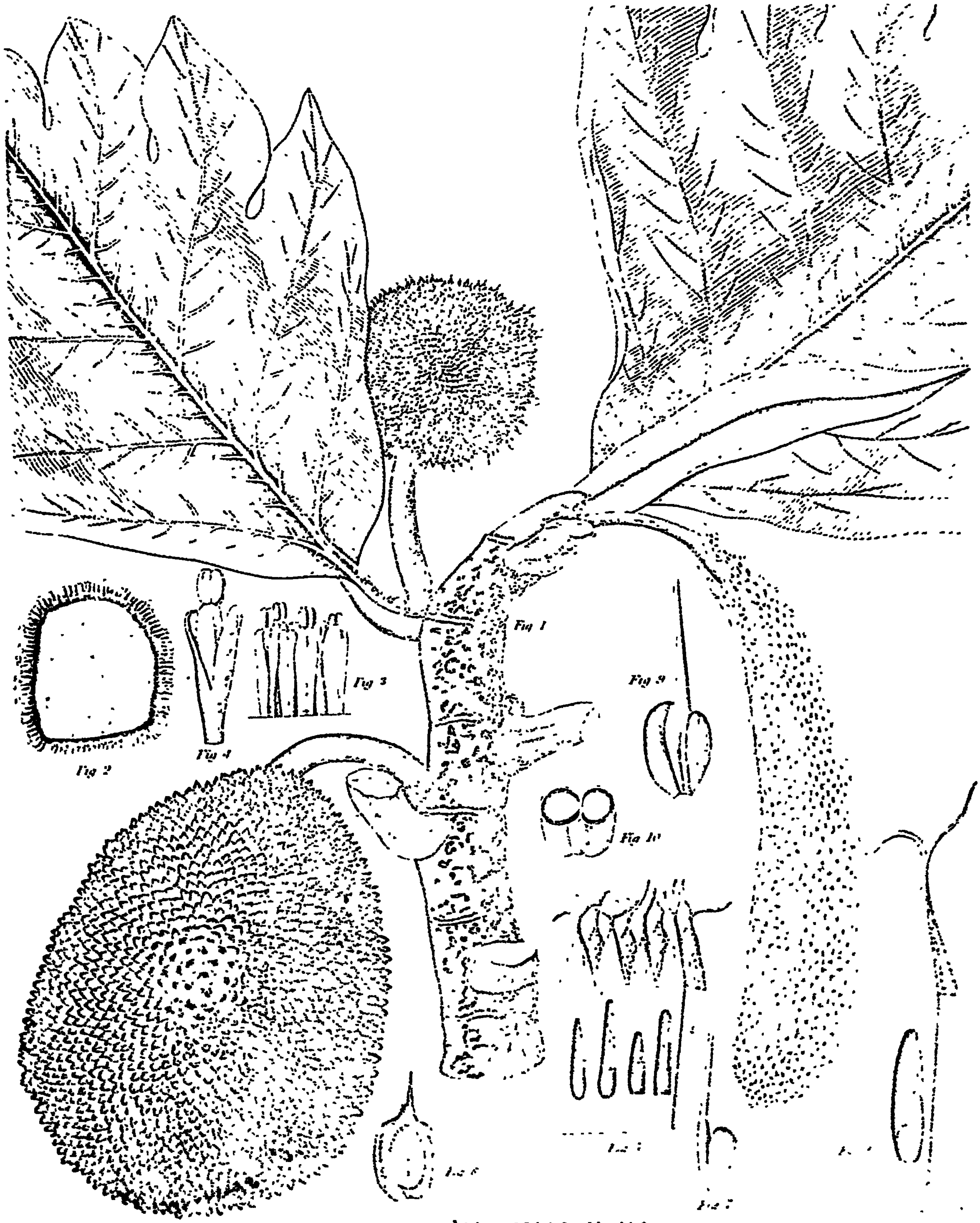
Purple Foxglove



Myristica moschata
(Nutmeg)

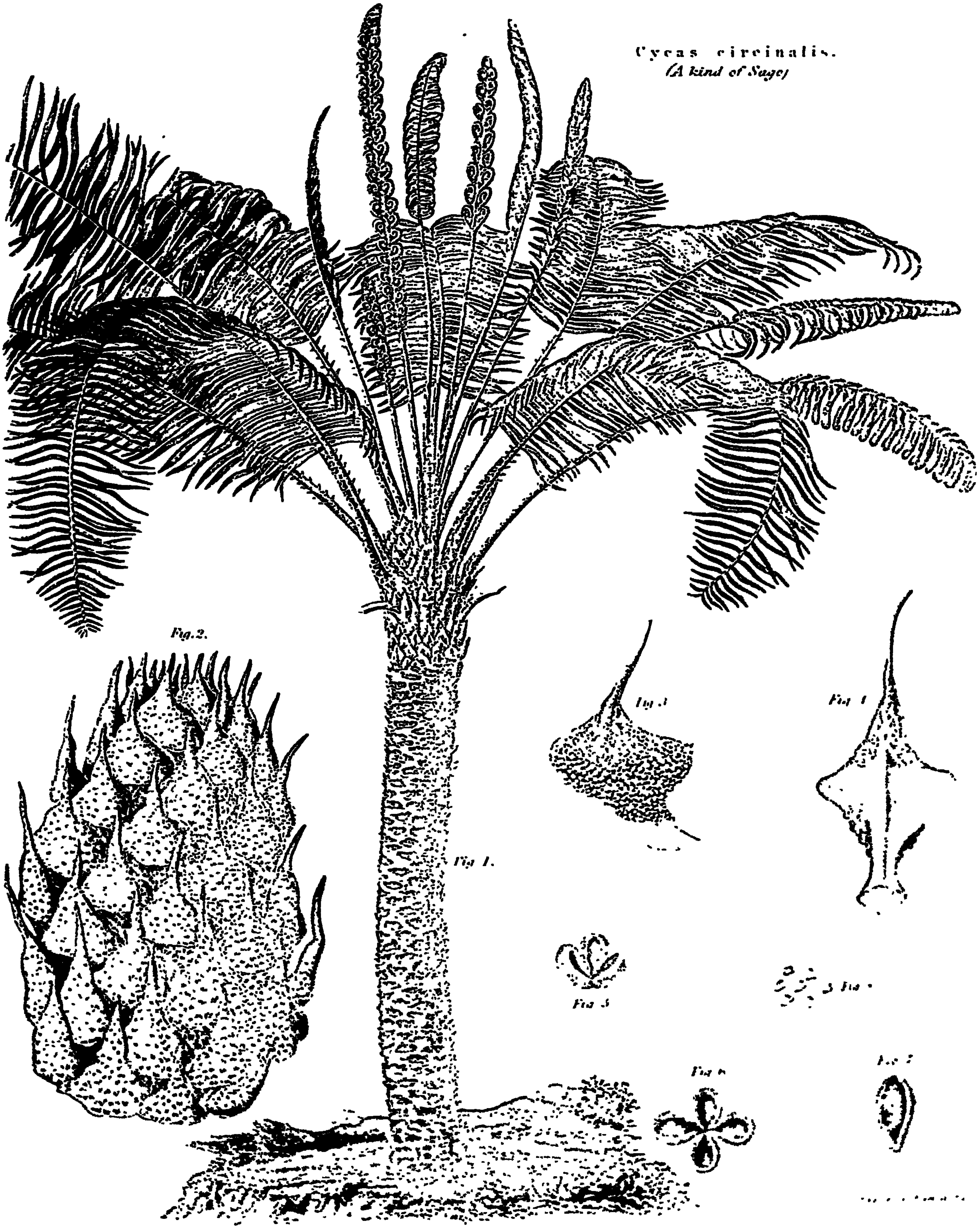


Euphorbia hypericifolia.



Artocarpus incisa
Bread-fruit Tree

Cycas circinalis.
(A kind of Sago)



Explanation of the Plates.

Plate I. Papaver Rhœas, Common Red Poppy, belonging to the Nat. Ord. Papaveraceæ. The leaves are pinnatifid, the peduncles have spreading hairs, the calyx consists of 2 caducous sepals, enclosing 4 crumpled petals, the stamens are indefinite and hypogynous, and the ovary is surmounted by a radiating stigma.

Fig. 1. Stamens inserted on the thalamus, below the ovary with its sessile stigma. Fig. 2. Capsule opening by pores below the sessile radiating stigmas.

Plate II. Janipha Manihot and Eschscholtzia californica.

Fig. 1. Janipha Manihot, Cassava plant, belonging to the Nat. Ord. Euphorbiaceæ. The leaves are digitately-partite, and the flowers are in racemose cymes. Fig. 2. Racemose cyme, with a pentacoccous capsule, which separates in an elastic manner into 5 single-seeded carpels. The cyme bears male as well as female flowers. Fig. 3. Pistil with stigma. Fig. 4. Stamens and fleshy disk. Fig. 5. Seed with strophiole.

Fig. 6. Eschscholtzia californica (*nat. size*), belonging to the Nat. Ord. Papaveraceæ. It has a peculiar caducous calyx like a candle-extinguisher, and a tetrapetalous corolla, with numerous hypogynous stamens. Fig. 7. Hollowed end of the peduncle, with the pistil. Fig. 8. Section of ovary, with numerous seeds attached to 2 parietal placentas. Fig. 9. Ceratium or siliquæform capsule (*nat. size*), opening by 2 valves. Fig. 10. Section of the seed, with the Dicotyledonous embryo, which is shown separately in fig. 11.

Plate III. Malva sylvestris, Common Mallow, belonging to the Nat. Ord. Malvaceæ. The leaves have 5 lobes, the inflorescence consists of cymose fascicles, and the æstivation is contortive.

Fig. 1. Calyx with a three-leaved epicalyx or involucre. Fig. 2. Obcordate petal, with monadelphous stamens. Fig. 3. Tube of stamens formed by union of the filaments. Fig. 4. Pistil with numerous carpels and styles. Fig. 5. Stamen with reniform anther opening round the margin. Fig. 6. Section of ovary composed of numerous carpels.

Plate IV. Anacardium occidentale, Cashew-nut plant, belonging to the Nat. Ord. Anacardiaceæ.

Fig. 1. Branch (*somewhat reduced*), bearing flowers and fruit. The flowers are in cymes, and the peduncles are enlarged in a pear-like form, bearing the nut (the true fruit) at their apex. Fig. 2. Flower not expanded. Fig. 3. Flower expanded. Fig. 4. Stamen and pistil, with the calyx; one fertile stamen longer than the others. Fig. 5. Stamen separated. Fig. 6. Nut constituting the fruit. Fig. 7. Nut opened longitudinally. Fig. 8. Seed separated from the nut. Fig. 9. Cotyledons opened to show the radicle *a*, and the plumule.

Plate V. Sarothamnus scoparius, Common Broom, belonging to the Nat. Ord. Leguminosæ or Fabaceæ, Sub-ord. Papilionaceæ. The angled branches bear ternate leaves, papilionaceous flowers, and legumes.

Fig. 1. Two-lipped calyx. Fig. 2. Broadly ovate vexillum or standard. Fig. 3. One of the alæ or wings of the corolla. Fig. 4. Carina or keel. Fig. 5. Monadelphous stamens. Fig. 6. Hairy ovary with the long style, thickened upwards, and spirally curved. Fig. 7. Legume or pod.

Plate VI. Carica Papaya and Andromeda hypnoides.

Fig. 1. Carica Papaya, the Papaw tree (*much reduced*), belonging to the Nat. Ord. Papayaceæ. The leaves are palmately-cleft, and the flowers unisexual. Fig. 2. Portion of a racemose cyme of infundibuliform male flowers, with united petals. Fig. 3. Gamopetalous male flower cut open, showing the ten epicorolline stamens alternately shorter. Fig. 4. Stamen. Fig. 5. Female flowers with a deeply-5-parted corolla.

Fig. 6. Andromeda hypnoides (*nat. size*), belonging to the Nat. Ord. Ericaceæ. Fig. 7. Flower of Andromeda, with 5-parted calyx, and gamopetalous campanulate corolla. Fig. 8. Back view of stamen with its 2-horned anther. Fig. 9. Front view of stamen with bicornute and biporose anther. Fig. 10. Pistil with its ovate acuminate style. Fig. 11. Capsule, 5-celled, with a central 5-lobed placenta.

Plate VII. Œnanthe crocata, Hemlock Water-Dropwort, belonging

an obsolete limb, an irregular sympetalous corolla, exserted stamens, and 1 style. Fig. 2. Pistil separated, with ovary, style, and stigma. Fig. 3. Monospermal fruit, with the persistent pappose limb of the calyx.

Plate IX. Leontodon Taraxacum, Common Dandelion, belonging to the Nat. Ord. Compositæ, Sub-ord. Cichoraceæ. The leaves are radical and runcinate, the flowers ligulate, and arranged in capitula. The outer phyllaries (involucral leaves) are reflexed.

Fig. 1. Capitulum with reflexed phyllaries and ligulate flowers. Fig. 2. A single flower, with inferior achene (cypsela), stipitate pappus, a ligulate corolla, 5 stamens united by their anthers, and 1 style with 2 stigmas. Fig. 3. Receptacle, become dry and convex, with deflexed phyllaries. Fig. 4. Linear-obovate achene.

Plate X. Cuscuta verrucosa, Warty Dodder, belonging to the Nat. Ord. Cuscutaceæ, which is often considered as a sub-order of Convolvulaceæ.

Fig. 1. Leafless flowering stem of Dodder (*nat. size*), turning from right to left (contrary to the motion of the sun). Fig. 2. Campanulate corolla, with 5 epicorolline stamens and alternating scales. Fig. 3. Persistent calyx. Fig. 4. Capsule opening transversely near the base. Fig. 5. Dissepiment and 2 seeds. Fig. 6. Bilocular capsule cut transversely, showing 2 seeds in each loculament. Fig. 7. Roundish compressed seed. Fig. 8. Seed cut longitudinally, showing the perisperm with the spirally-rolled-up embryo.

Plate XI. Digitalis purpurea, Purple Foxglove, belonging to the Nat. Ord. Scrophulariaceæ.

Fig 1. Calyx in 5 deep segments, with the pistil. Fig. 2. Pistil separated. Fig. 3. Didynamous stamens. Fig. 4. Stamens, with the anther-lobes collateral and unopened. Fig. 5. Capsule cut transversely, showing two loculaments.

Plate XII. Myristica moschata, the Nutmeg-tree, belonging to the Nat. Ord. Myristicaceæ.

Fig. 1. Male plant (*nat. size*) with oblong nearly elliptical leaves, and flowers in axillary umbellate cymes. Fig. 2. Perianth of male plant laid open to show the stamens with their united filaments. Fig. 3. Anther, bilocular, and opening longitudinally. Fig. 4. Female flower cut open, showing the single pistil, with short style and 2-lobed stigma. Fig. 5. Young fruit. Fig. 6. Ripe drupaceous fruit in the act of bursting, and showing the mace or arillode. Fig. 7. Section of the ripe fruit. Fig. 8. The nut, consisting of a hard endocarp enclosing the seed. Fig. 9. The oval seed. Fig. 10. The seed cut vertically. Fig. 11. Vertical section of endocarp and seed, showing ruminate perisperm and the embryo. Fig. 12. Embryo, showing 2 large foliaceous plicate cotyledons. Fig. 13. Embryo with radicle and cotyledons.

Plate XIII. Euphorbia hypericifolia, Tutsan-leaved Spurge, belonging to the Nat. Ord. Euphorbiaceæ.

Fig. 1. Plant (*nat. size*) with opposite oblong leaves, and flowers in corymbose cymes. Fig. 2. Involucre with appendages, enclosing male and female flowers. Fig. 3. Involucre cut open, to show the insertion of the numerous achlamydeous male monandrous flowers, and the single naked female flower, all pedicellated. Fig. 4. Involucre deprived of its petaloid appendages, with female flower showing forked styles. Fig. 5. Involucre enclosing the ripe fruit (regma). Fig. 6. Stamen. Fig. 7. Fruit with one of the cocci separated from the columella. Fig. 8. Seed. Fig. 9. Seed cut open, showing fleshy perisperm and inverted embryo.

Plate XIV. Artocarpus incisa, the Bread-fruit tree, belonging to the Nat. Ord. Artocarpaceæ.

Fig 1. Branch reduced to 1/3rd its natural size, with cuneate-ovate pinnatifid leaves, male flowers in a club-shaped deciduous catkin, female flowers in rounded clusters. Fig. 2. Transverse section of the male amentum with numerous flowers. Fig. 3. Male flowers. Fig. 4. Single male flower separated, with a perianth in 2 segments and a single stamen. Fig. 5. Female flowers. Fig. 6. Single female flower separated, with ovary, style, and bifid stigma. Fig. 7. Ovary. Fig. 8. Ovary laid open to show the ovule. Fig. 9. A variety of the ovary with 2 loculaments. Fig. 10. Transverse section of a bilocular ovary.

Plate XV. Cycas circinalis, a species of false Sago-plant, belonging

BOTANY BAY, an inlet on the eastern coast of Australia, to the S. of the city of Sydney, in the Cumberland district of New South Wales, in 34° S. lat. and 151° 15′ E. long. In was first visited by Captain Cook in 1770, and received its name from Joseph Banks, the botanist of the expedition, on account of the variety of its flora. When, on the revolt of the New England colonies, the convict establishments in America were no longer available, the attention of the British Government, then under the leadership of Pitt, was turned to Botany Bay; and in 1787 Commodore Phillip was commissioned to form a penal settlement there. Finding, on his arrival, however, that the locality was ill-suited for such a purpose, he removed northwards to the site of the present city of Sydney. The name of Botany Bay seems to have struck the popular fancy, and continued to be used in a general way for any convict establishment in Australia. The transportation of criminals to New South Wales was discontinued in 1840.

BOTHNIA, an ancient province of Sweden, which was divided into East and West by the gulf of the same name. The eastern division, which was bounded on the N. by Lapland, E. by Archangel and Olonetz, and S. by Finland, is now incorporated with the last-mentioned district, having been ceded to Russia in 1809. The western division now forms part of the Swedish province of Norrland, two departments of which are still known, the one as Vesterbotten or West Bothnia, and the other as Norrbotten or North Bothnia. The name is probably derived from the Scandinavian *botn*, a lake.

BOTHNIA, GULF OF, the northern part of the Baltic, so called from the above province. See BALTIC SEA.

BOTHWELL, a village of Scotland, in Lanarkshire, situated near the River Clyde, about 8½ miles S.E. of Glasgow, and a favourite resort of the inhabitants of that city. It contains a Gothic church of some antiquity; and about a mile from the village are the ruins of Bothwell Castle and the modern mansion of Lord Douglas. In the neighbourhood is the scene of the famous battle of Bothwell Bridge, which was fought between the Covenanters and the forces of the duke of Monmouth, June 22, 1679. Bothwell is one of the most ancient baronies in Scotland, and gives a title to a series of families distinguished in the history of Scotland. Joanna Baillie was born in the village manse. The population of the parish in 1871 was 9193.

BOTHWELL, JAMES HEPBURN, EARL OF, in the peerage of Scotland, only son of Patrick, third earl of Bothwell, was born about 1526. Nothing is known of his life up to the date of his father's death, 1556, when he was served heir to his vast estates. For the next few years notices of his doings are few and obscure; he undoubtedly held posts of high dignity, such as the wardenship of the Scottish Borders, and the office of Lord Admiral; and it is certain that he was a vigorous opponent of the "lords of the congregation." In the end of 1560 he appears to have been one of the lords who went over to France to meet their new queen (Mary). In 1562 occurred the singular and obscure episode of the conspiracy between Bothwell and Arran to carry off the queen. Arran was well known to be deeply enamoured of Mary, and Bothwell apparently intended to use this passion as a means of furthering his own designs against Murray. The plot, or the germ of it was discovered; Arran was found to be all but insane, and an indictment was laid against Bothwell, who fled to France and remained there till 1565, when he returned to Scotland. The charge, however, was not forgotten; it was renewed by the earl of Murray, and the day of trial was fixed. But Murray's forces were too umerous to make it safe for Bothwell to make his aparance, and he again fled. He reappeared at court in a rt time after the marriage of the queen with Darnley, and began to rise rapidly into favour. He escaped from the palace after the murder of Rizzio, and with great promptitude drew together some forces for the queen's defence. From this time onwards he was in the highest favour with the queen, and all powerful at court. In 1566 he was dangerously wounded when on a judicial tour in Liddesdale. Here the queen paid him a visit, riding all the way from Jedburgh, where she was holding a justice eyre. The fatigues of this ride of forty miles brought on a severe illness, during which her life was despaired of. After her recovery the project of a divorce from Darnley was mooted, but was declined by her, and Bothwell seems then to have resolved on the removal of her husband by any means. On the evening of the 9th of February the famous crime was committed of Darnley's murder. Public opinion, expressing itself in placards and outcries, fastened the guilt upon Bothwell and his associates, but he was too powerful to be dealt with by the law. On the 24th April he played his last move, carrying off Mary to Dunbar Castle, which had been granted him by the Queen. A divorce from his former wife was easily procured, the dispensation in their favour not being produced at the trial, and on the 15th May the royal marriage was completed. Mary had a few days previously pardoned Bothwell for his abduction of her, and had raised him to the rank of duke of Orkney. The fancied security in which they passed the few days after their marriage was soon and rudely dispelled. The great lords collected their forces and seized Edinburgh, Bothwell and the queen escaping with the greatest difficulty to Dunbar. At Carberry Hill the opposing parties met; Mary surrendered to the lords, and Bothwell fled to Dunbar and thence to Orkney. Being closely pursued he took ship, was captured by a Danish cruiser, and confined for a time at Copenhagen. He was removed to Malmö and afterwards to Draxholm Castle, where he died in 1575. He is said to have made a death-bed confession exonerating the queen, but the authenticity of the report is more than doubtful. There is hardly a redeeming point in Bothwell's character; he was utterly selfish and brutal, and did not even treat with courtesy or kindness the woman who had risked so much for his sake. (See Tytler and Burton's histories of Scotland.)

BOTTA, CARLO GIUSEPPE GUGLIELMO, Italian historian, was born in 1766 at San Giorgio, in Piedmont. He studied medicine at the university of Turin, and obtained his doctor's degree when about twenty years of age. Having rendered himself obnoxious to the Government during the political commotions that followed the French Revolution, he was imprisoned for nearly two years; and on his release in 1794 he withdrew to France, only to return to his native country as a physician in the French army, whose progress he followed as far as Venice. Here he joined the expedition to Corfu, from which he did not get back to Italy till 1798. From that year, when he was appointed by Joubert a member of the provisional government at Piedmont, till the fall of the Napoleonic system in 1814, he continued to have considerable political influence; and though towards the close of that period he acted with an independence that proved offensive to Napoleon himself, and on the restoration of the Bourbons adapted his conduct to the circumstances of the time, he was still in sufficient favour with the Bonapartist party to receive from them, during their brief resumption of authority in 1815, the appointment (soon afterwards resigned) of rector of the university at Rouen. Amid all the vicissitudes of his early manhood Botta had never allowed his pen to be long idle, and in the political quiet that followed 1816 he naturally devoted himself more exclusively to literature. By 1824 he had completed a history of Italy from 1789 to 1814 (4 vols.), on which his fame principally rests, for

though the continuation of Guicciardini, which he was afterwards encouraged to undertake, is a careful and laborious work, he had not the erudition necessary for the satisfactory restoration of the past. Though living in Paris he was in both these works the ardent exponent of that recoil against everything French which took place throughout Europe. A careful exclusion of all Gallicisms is one of the marked features of his style, which is not unfrequently impassioned and eloquent, though at the same time cumbrous and founded upon antiquated models. Botta died at Paris in August 1837, in comparative poverty, but in the enjoyment of an extensive and well-earned reputation. His son, Paul Émile Botta (1805–1870), was a distinguished traveller and Assyrian archæologist. His excavations at Khorsabad (1843) were among the first efforts in the line of investigation afterwards pursued by Mr Layard.

The works of Carlo Botta are—*Description de l'île de Corfou*, 1799; an Italian translation of Born's *Joannis Physiophili specimen monachologiæ*, 1801; *Souvenirs d'un voyage en Dalmatie*, 1802; *Mémoire sur la nature des tons et des sons*, 1803; *Storia della guerra dell' Independenza d'America*, 1810; *Camillo*, a poem, 1816; *Storia d'Italia dal 1789 al 1814*, 1824; *Storia d'Italia in continuazione al Guicciardini*, 1832, &c., &c.

BOTTICELLI, SANDRO (for ALESSANDRO), one of the most original and fascinating painters of the school of Florence. Like many Italian artists, he is called not after his father but after the master under whom he learned his first lessons in art. He was the youngest son of a citizen named Mariano Filipepi, and was born at Florence in the year 1447. It is related how as a child, though quick at whatever he chose to do, he was restless and wayward, and would not take kindly to "any sort of schooling in reading, writing, or arithmetic;" so that his father put him, in despair, to learn the goldsmith's trade with a gossip of his own named Botticello. Thus his first training, like that of Ghirlandaio and many of the best artists of the time, was in jewellery and metal working. He showed talent and fancy, and was presently transferred from the school of Botticello the goldsmith to that of Lippo Lippi the Carmelite brother, then in the height of his practice and reputation as a painter. Under that master Sandro acquired a perfect proficiency, and on his death in 1468 appears to have begun independent practice. The special characteristic of Lippo Lippi's style had been its union of a buoyant human spirit of life and enjoyment with the utmost simplicity and tenderness of religious feeling. In Botticelli there was more than all the fire of his master, and more than all his delight in beauty, together with a sentiment which was altogether personal to himself. All his creations are coloured with an expression of eager and wistful melancholy, of which it is hard to penetrate the sense and impossible to escape the spell. Whether he paints a Madonna with her child surrounded by angels, or a Venus among her Graces and Cupids, the countenances which he shows us are of a kindred type, and have upon them the pale cast of the same nameless passion. He was an artist of immense invention and industry, and in the early part of his career painted in oil and tempera a vast number of pictures both in the classical and the Christian vein. No other work expresses the spirit of the time in a more interesting way, or with so much imaginative refinement and technical charm. His dejected types have an infinite beauty of their own, and though his figures are not designed with perfect science, and have some tendency to attenuation, and to coarseness of the hands and feet, they are nevertheless drawn with a determination and finish in the contours, and modelled with a fulness and delicacy of relief, which belong only to the most accomplished art.

Of all the Florentine school, Botticelli is the richest and most fanciful colourist,—often using gold to enrich the lights on hair, tissues, and foliage, with a very exquisite effect. That may be the consequence of his early employment upon goldsmith's work, as is, more certainly, his minute solicitude in all the accessory details and ornaments of his compositions. The patterned and embroidered dresses, the scarves and head-gear of his figures, are often treated with an incomparable invention and delicacy. No artist has ever painted flowers with a more inspired affection, and especially roses, with which he was wont to fill the backgrounds of his pictures. He preferred, it would seem, the circular form for his compositions; and a large number of devotional pieces in this form, by his own hand and that of his scholars, are scattered through the museums and private collections of Europe, and are among the most poetical examples of religious art that Italy has left us. He went even beyond his master Lippo Lippi, and the sculptors Luca della Robbia, Donatello, and Desiderio da Settignano, in the touching and engaging character of the children who minister, in the form of angels, to his sacred personages. He designed choirs of such or of grown-up angels dancing between earth and heaven, or circles of them ranged in the order of the celestial hierarchies, with a variety of grouping and a graceful fire of movement that was a new thing in his art. One of the best examples of this kind of work is a round numbered 33 in the gallery of the Uffizj at Florence. Another very famous example of his devotional art is a picture of the Coronation of the Virgin executed for Matteo Palmieri, a Florentine man of letters and speculative philosopher, with whom the painter was intimate, and who gave suggestions for the design of the picture. It represents the Virgin and Christ surrounded by the celestial hierarchies according to the scheme (with some slight divergencies) of Dionysius the Areopagite,—on the ground beneath, the donor and his wife kneeling at either side of the Virgin's tomb, the Val d'Arno and the city of Florence in the distance. This picture is now the property of the duke of Hamilton. But the grandest of all his altar-pieces is that numbered 47 in the Florence Academy, with a group of life-sized saints on the ground and a dance of angels above. In the Uffizj is an Adoration of the Magi, in which Botticelli has introduced the portraits of Cosimo, Giuliano, and Giovanni de' Medici. By that house he, like all the artists of his time, was much befriended; and for Lorenzo's villa at Castello he painted the most beautiful of his pictures of classical mythology, the Birth of Venus now at the Uffizj, and the Venus with the Graces now at the Florence Academy. The National Gallery possesses two smaller but admirable works of the master in the same vein. An allegorical figure of Fortitude, designed for a series of which the rest were painted by the brothers Pollaiuoli, and now in the Uffizj; a picture composed from Lucian's account of the Calumny of Apelles in the same gallery; a series illustrating Boccaccio's story of Nastagio degli Onesti, which has passed into private hands in England—these instances will suffice to show the variety of themes upon which Botticelli exercised his genius. A St Augustine, painted by him in rivalry with Ghirlandaio in the church of the Ognissanti, and still existing, is said to have won great praise from his contemporaries for its exhibition, in the head of the saint, of "that profound cogitation and most acute subtlety which we are wont to find in persons who are of thoughtful habit and continually abstracted in the investigation of things the most deep and difficult."

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wards that he was summoned to Rome by Sixtus IV., to decorate the walls of his new chapel in the Vatican. Among the great scenes in fresco painted on those walls by Domenico Ghirlandaio, Cosimo Rosselli, Signorelli, and Perugino, three subjects from the hand of Botticelli hold their place with the noblest. They represent the Life of Moses, the Destruction of Korah, Dathan, and Abiram, and the Temptation of Christ. In 1482, probably after his return from Rome, he received a commission to paint in the Sala dell' Udienza at Florence, together with Domenico Ghirlandaio. Many of the works already mentioned probably fall within the next ten years of Botticelli's manhood. The Boccaccio series belongs to 1487. In 1491 he was engaged, together with the brothers Ghirlandaio, upon some mosaic decorations in the cathedral of Florence which have unhappily perished. Soon after this time there came into his life a new influence which greatly changed it. It is well known how the genius of the Dominican Savonarola swept like a storm over the affairs of Italy, and what a revolution, after the passage of the French king through Florence, he brought about in the temper and policy of the republic,—driving out the merchant family who had been its untitled masters for half a century, establishing in place of their rule a new theocracy of which he was himself the oracle and minister, turning the hearts of old and young away from the world and from their lusts. Many of the first artists of the city became his most ardent followers, and among them Botticelli. What the actual effect of his conversion was upon him we have scanty means of judging, but it needs must have put an end to his painting of those old mythologies, over which in earlier days his imagination had been used to throw so singular a charm. Vasari, a devoted servant of the later Medici, and therefore a traducer of the greatest enemy that house had ever had, speaks of Savonarola's influence upon Botticelli as altogether disastrous, saying that he was "obstinate upon that side," "a partisan of the sect of Savonarola in such a fashion that, abandoning painting and having no income to live upon, he fell into the utmost disorder;" and again how, "playing the Piagnone (the name given to the followers of Savonarola), he fell out of the way of painting, and thereby at last found himself old and poor in such a sort that if Lorenzo Medici, as long as he lived, had not supported him, and afterwards his friends and many worthy men who felt an affection for his virtues, he would, we may say, have died of hunger." We have few materials by which we can test the accuracy of this account. We know that in 1496 the young Michelangelo sent through his hands a letter addressed to this Lorenzo de' Medici (Lorenzo the younger, that is,—the son of Giuliano); that in 1498 he was living with a brother in the quarter called Sta Lucia of Ognissanti; that in 1503 he was consulted along with other artists as to the best place for Michelangelo's colossal statue of David. But of more importance and significance than all this is a beautiful picture of a Nativity with mystical by-scenes, in the possession of Mr Fuller Maitland, which bears an inscription in base Greek by the master himself. The inscription seems to construe thus:—"This picture I, Alessandro, painted at the end of the year 1500, in the troubles of Italy, in the half-time after the time, during the fulfilment of the eleventh of John, in the second woe of the Apocalypse, in the loosing of the devil for three and a half years. Afterwards he shall be chained according to the twelfth of John, and we shall see him trodden down as this picture." Hence it appears to be established that Botticelli, a year and a half after the downfall and execution of Savonarola, had his mind full of his instructions and prophecies; that he regarded the death of the Dominican reformer and his companions as the fulfilment of the Apocalyptic prophecies about the slaying of the witnesses; that he thought of the tribulations among which he lived as the "second woe" of Rev. xi., and as coincident with the "time, times, and half a time" of that and other prophetic writings; and finally—such is the originality and excellence of the work—that his imagination had at this time lost none of its fire nor his hand of its cunning. We are quite without the means of deciding whether any proportion of the large existing mass of his undated works belong to the years following this; or whether we are really to think of him as failing in his wonted industry in his latter days, from regret and disappointment at his master's fate and at public affairs, from pre-occupation over mystical theology (which had always had an attraction for him, and, in the case of the picture painted early in his life for Matteo Palmieri, had brought upon him a charge of heresy), or, lastly, from another cause which Vasari alleges, but which we have designedly passed by till this place.

In the history of engraving there are no productions more precious, more interesting, or more problematical than a number of plates executed in a primitive style, with severe outlines and straight lines of shading, by artists of the Florentine school towards the close of the 15th century. The engravings in this manner include some two hundred and fifty pieces, covering the whole range of subjects that interested the mind of Italy at this most active and fanciful moment of the early Renaissance. The best known of these engravings are as follows:—three designs to the earliest book published in Florence with engraved illustrations, called *Il Monte Sancto di Dio* (1471); a set of nineteen designs to an edition of the *Divina Commedia* of Dante (1481); a set of twenty-four Prophets; a set of twelve Sibyls; several subjects of Saints; several of mythology, such as the Death of Paris, Theseus and Ariadne, the Judgment of Paris, Loves in a Vineyard, and the like; a famous series (long falsely ascribed to Mantegna, whose manner in engraving is easily distinguishable from this) of the Ranks and Professions of Men, the Virtues, the Arts and Sciences, the Muses, and the Planets (fifty in all); a series of fifteen setting forth the lives of Mary and of Christ; a subject of the deluge; another of the preaching of the Franciscan Fra Marco, and many more. Between the various examples of this large class there are considerable differences, but they are all unlike the work of any other school, and all manifestly Florentine of the 15th century. Conjectures the most confident and at the same time the most conflicting have been put forward as to their authorship. All such conjectures alike have been based on a few passages in Vasari's lives of Botticelli and of Marc Antonio. According to Vasari, the first Florentine who took impressions on paper from engravings was Maso Finiguerra, and he, says our author, was "followed by Baccio Baldini, who not having much power of designing, all that he did was with the invention and design of Sandro Botticelli." And again, Vasari says of Botticelli that, "from being a sophistical (*i.e.*, thoughtful or ingenious) person, he commented a part of Dante, and made figures for the *Inferno*, and put them into print; upon which pursuit he spent a deal of time; so that not working" (*i.e.*, at painting) "it was a cause of infinite disorders in his life. He put in print many more things of his own from designs which he had made, but in a bad manner." On the strength of those passages this whole class of early Florentine engravings has generally been put down by connoisseurs, as, for instance, Young Ottley, Bartsch, and Passavant, as the work of Sandro Botticelli and Baccio Baldini, jointly or apart,—each critic attributing separate subjects to the one or the other of the artists according to his private canon of internal evidence. But a scrupulous examination shows this internal evidence to be both very meagre and very contradictory. Nor can much be built upon the external

testimony of Vasari. The phrase "put into print" is ambiguous, and by it Vasari may mean us to understand either that Botticelli engraved the designs himself or else that he merely furnished them to be engraved by another hand. To him the chief part in the invention, to Baldini the chief part in the execution, is usually and with a fair measure of probability assigned. Vasari's information on the whole subject was evidently loose; a Triumph of Faith of Savonarola, which he extols as Botticelli's best engraving, does not at present exist at all. None of the designs bear the evidence of Botticelli's manner in a sufficiently definite form to be undeniable. On the other hand, many of them, by their poetry, their refinement, their singularity, are quite worthy of his hand, nor do they resemble any other contemporary style more than his. If he designed and executed, or in part executed, them, they are no slight addition to his fame, and a noble vindication of his industry during that old age of idleness, decay, and "disorder," which followed, if we are to believe Vasari, upon the splendid and inspired activity of his youth and manhood. But the question is one which criticism, it is to be feared, will never have the means of fully settling. (Vasari, ed. Lemonnier, vol. v. pp. 110–127; Crowe and Cavalcaselle, *Hist. of Painting in Italy*, vol. ii. pp. 414–430; W. H. Pater, *Studies in the History of the Renaissance*; and see also *Ariadne Florentin*, No. vi., by John Ruskin; art. "Baccio Baldini," by E. Kolhoff in 2d ed. of Nagler's *Künstler-Lexikon*; and the *Academy* for February 1871.)

BÖTTIGER, KARL AUGUST, a distinguished German archæologist, was born at Reichenbach in 1760. He was educated at the famous school of Pforta, and at the University of Leipsic. In 1784, after having passed a few years as private tutor in Dresden, he was made rector of the school at Guben, where he remained for six years. He was then transferred to a similar post at Bautzen, and in 1791, through the influence of Herder, obtained the appointment of rector of the gymnasium at Weimar. In that town he entered into a circle of literary men of the highest powers, including Wieland, Schiller, and Goethe, and distinguished himself by the great versatility of his talents. He published in 1803 a lively and learned work, *Sabina, oder Morgenscenen einer reichen Römerin*, giving a description of a wealthy Roman lady's toilette, and a work on ancient art, *Griechische Vasengemälde*. At the same time he assisted in editing the *Journal des Luxus und der Mode*, the *Deutsche Mercur*, and the *London and Paris*. In 1804 he was called to Dresden as superintendent of the studies of the court pages, and received the rank of privy councillor. In 1814 he was made director of studies at the court academy, and inspector of the Museum of Antiquities. He died at Dresden in 1835.

Of his numerous works, most of which are devoted to ancient art, the following seem most worthy of notice:—*Ideen zur Archäologie der Malerei*, 1811; *Kunstmythologie*, 1811; *Vorlesungen und Aufsätze zur Alterthumskunde*, 1817; *Amalthea*, 3 vols., 1821-25; *Ideen zur Kunstmythologie*, 2 vols., 1826–36. The *Opuscula et Carmina Latina* were published separately in 1837, with a collection of his smaller pieces, *Kleine Schriften*, 3 vols., 1837–8. A sketch of his biography has been written by his son, Karl Wilhelm Böttiger (1790-1862), for some time professor of history at Erlangen, who is well known as the author of several valuable histories (*History of Germany*, *History of Saxony*, *History of Bavaria*, *Universal History in biographies*.)

BOTTLE. The first bottles were probably made of the skins of animals. In the *Iliad* (iii. 247) the attendants are represented as bearing wine for use in a bottle made of goat's skin, ἀσκῷ ἐν αἰγείῳ. The ancient Egyptians used skins for this purpose, and from the language employed by Herodotus (ii. 121), it appears that a bottle was formed by sewing up the skin and leaving the projection of the leg and foot to serve as a vent, which was hence termed ποδεών. The aperture was closed with a plug or a string. Skin bottles of various forms occur on Egyptian monuments. The Greeks and Romans also were accustomed to use bottles made of skins; and in the southern parts of Europe they are still used for the transport of wine. The

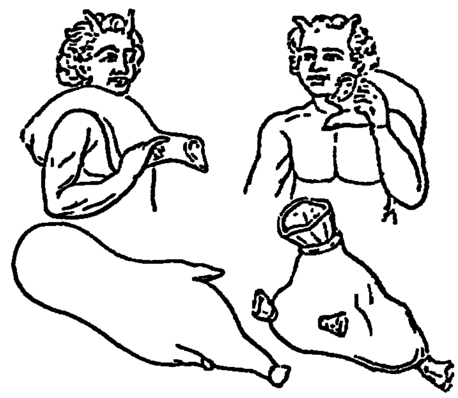

FIG. 1.—Roman Skin Bottles.

accompanying illustration is from specimens at Pompeii and Herculaneum. The first explicit reference to bottles of skin in Scripture occurs in Joshua (ix. 4), where it is said that the Gibeonites took "old sacks upon their asses, and wine-bottles *old and rent and bound up*." Skins are still most extensively used throughout Western Asia for the conveyance and storage of water. It is an error to represent the bottles of these ancient Hebrews as being made exclusively of skins. In Jer. xix. 1, the prophet speaks of "a potter's earthen vessel." The Egyptians possessed vases, bottles, &c., of hard stone, alabaster, glass, ivory, bone, porcelain, bronze, silver, and gold, and also, for the use of the people generally, of glazed pottery or common earthenware. As early as Thothmes III., assumed to be the Pharaoh of the Exodus (1490, B.C.), vases existed of a shape so elegant, and of workmanship so superior, as to show that the art was not, even then, in its infancy. In the annexed cut various specimens of these are represented.

FIG. 2.—Egyptian Bottles and Vases.—1, 2. Gold. 3. Cut glass. 4. Earthenware. 5, 7. Porcelain. 6. Hard Stone. 8. Gold, with plates and bands. 9. Stone. 10. Alabaster, with lid.

The British Museum contains a fine collection of these articles. The process of making glass bottles is described under the heading GLASS.

BOTTOMRY, a maritime contract by which a ship (or bottom) is hypothecated in security for money borrowed for expenses incurred in the course of her voyage, under the condition that if she arrive at her destination the ship shall be liable for repayment of the loan, together with such premium thereon as may have been agreed for; but that if the ship be lost, the lender shall have no claim against the borrower either for the sum advanced or for the

premium. The freight may be pledged as well as the ship, and, if necessary, the cargo also. In some cases the personal obligation of the ship-master is also included. When money is borrowed on the security of the cargo alone, it is said to be taken up at *respondentia*; but it is now only in rare and exceptional cases that it could be competent to the ship-master to pledge the cargo, except under a general bottomry obligation, along with the ship and freight. In consideration of the risks assumed by the lender, the bottomry premium (sometimes termed *maritime interest*) is usually high, varying of course with the nature of the risk and the difficulty of procuring funds.

A bottomry contract may be written out in any form which sufficiently shows the conditions agreed on between the parties; but it is usually drawn up in the form of a *bond*. The document must show, either by express terms or from its general tenor, that the risk of loss is assumed by the lender,—this being the consideration for which the high premium is conceded. The lender may transfer the bond by endorsation, in the same manner as a bill of exchange or bill of lading, and the right to recover its value becomes vested in the indorsees.

According to the law of this country, a bottomry contract remains in force so long as the ship exists *in the form of a ship*, whatever amount of damage she may have sustained. Consequently, the "constructive total loss" which is recognized in marine insurance, when the ship is damaged to such an extent that she is not worth repairing, is not recognized in reference to bottomry, and will not absolve the borrower from his obligation. But if the ship go to pieces, the borrower is freed from all liability under the bottomry contract; and the lender is not entitled to receive any share of the proceeds of such of the ship's stores or materials as may have been saved from the wreck. Money advanced on bottomry is not liable in England for general average losses.

If the ship should *deviate* from the voyage for which the funds were advanced, her subsequent loss will not discharge the obligation of the borrower under the bottomry contract. If she should not proceed at all on her intended voyage, the lender is not entitled to recover the bottomry premium in addition to his advance, but only the ordinary rate of interest for the temporary loan. As the bottomry premium is presumed, in every case, to cover the risks incurred by the lender, he is not entitled to charge the borrower with the premium which he may pay for *insurance* of the sum advanced, in addition to that stipulated in the bond.

The contract of bottomry seems to have arisen from the *custom* of permitting the master of a ship, when in a *foreign* country, to pledge the ship in order to raise money for repairs, or other extraordinary expenditures rendered necessary in the course of the voyage. Circumstances often arise, in which, without the exercise of this power on the part of the master, it would be impossible to provide means for accomplishing the voyage; and it is better that the master should have authority to burden the ship, and, if necessary, the freight and cargo also, in security for the money which has become requisite, than that the adventure should be defeated by inability to proceed. But the right of the master to pledge the ship or goods must always be created by necessity; if exercised without necessity the contract will be void. Accordingly, the master of a British ship has no power to grant a bottomry bond at a British port, or at any foreign port where he might raise funds on the personal credit of the shipowners. Neither has he any power to pledge the ship or goods for private debts of his own, but only for such supplies as are indispensable for the purposes of the voyage. And in all cases he ought, if possible, to communicate with the owners of the ship, and with the proprietor of the cargo before pledging their property. Facility of communication, by telegraph and otherwise, has of late years given additional stringency to this rule.

The bottomry lender must use reasonable diligence to ascertain that a real necessity exists for the loan; but he is not bound to see to the application of the money advanced. If the lender has originally advanced the funds on the personal credit of the owner he is not entitled to require a bottomry obligation. A bond procured from the shipmaster by improper compulsion would be void.

The power of the master to pledge the cargo depends upon there being some reasonable prospect of benefit to it by his so doing. He has no such power except in virtue of circumstances which may oblige him to assume the character of *agent for the cargo*, in the absence of any other party authorized to act on its behalf. Under ordinary circumstances he is not at liberty to pledge the cargo for repairs to the ship. If indeed the goods be of a perishable nature, and if it be impossible to get the ship repaired in sufficient time to obviate serious loss on them by delay, without including them under the bottomry contract, he has power to do so, because it may fairly be assumed, in the case supposed, that the cargo will be benefited by this procedure. The general principle is, that the master must act for the cargo, with a reasonable view to the interests of its proprietors, under the whole circumstances of the case. When he does this his proceedings will be sustained; but should he manifestly prejudice the interests of the cargo by including it under bottomry for the mere purpose of relieving the ship, or of earning the freight, the owners of the cargo will not be bound by the bottomry contract. Any bottomry or respondentia bond may be good in part or bad in part, according as the master may have acted *within* or *beyond* the scope of his legitimate authority in granting it. If two or more bottomry bonds have been granted at different stages of the voyage, and the value of the property be insufficient to discharge them all, the last dated bond has the priority of payment, as having furnished the means of preserving the ship, and thereby preventing the total loss of the security for the previous bonds.

When the sum due under a bottomry bond over ship, freight, and cargo is not paid at the stipulated time, proceedings may be taken by the bondholder for recovery of the freight and for the sale of the ship; and should the proceeds of these be insufficient to discharge the claim, a judicial sale of the cargo may be resorted to. As a general rule the value of the ship and freight must be exhausted before recourse can be taken against the cargo. A bottomry bond gives no remedy to the lenders against the owners of the ship or cargo personally. The whole liability under it may be met by the surrender of the property pledged, whether the value so surrendered covers the amount of the bond or not. But the owners of the ship, though not liable to the bondholder for more than the value of the ship and freight, may be further liable to the proprietors of the cargo for any sum in excess of the cargo's proper share of the expenses, taken by the bondholder out of the proceeds of the cargo to satisfy the bond after the ship and freight have been exhausted.

The bottomry premium must be ultimately paid by the parties for whose benefit the advances were obtained, as ascertained on the final adjustment of the average expenditures at the port of destination.

See the cases of the "Gratitudine," 2 Rob. A. R., 240, 272; the "Lord Cochrane," 8 Jur., 714; the "Cynthia," 20 L. T., 7, 54; the "Bonaparte," 14 Jur., 605; Benson *v.* Duncan, 14 Jur., 218; Benson *v.* Chapman, 5 C. B., 330; 8 C. B., 950; Shee's Marshall *On Insurance*, part ii.; Arnould *On Insurance*; Pritchard's *Admiralty Digest*.

(J. WA.)

BOTZEN, BOZEN, or BOLZANO (the ancient *Pons Drusi*), a town of Austria, the capital of the circle of Brixen in Tyrol, is situated at a height of 1120 feet near the confluence of the Talfer and the Eisack, 32 miles N.N.E. of Trent. The town is well built in the Italian style, and has a fine old Gothic church of the 14th and 15th centuries, a castle, several churches and convents, and a gymnasium. Situated at the intersection of roads from Italy, Germany, and Switzerland, it has an extensive transit trade, and its four large annual fairs date from 1024. It has also manufactures of linen, cotton, silk, hosiery, leather, and wax. It is protected from sudden inundations by a strong dike of masonry nearly two miles in length, and in some parts 24 feet thick. Botzen is mentioned as early as 378. In the 9th century it was the seat of a Bavarian countship, but in 1027 it was presented to the prince-bishop of Trent by the Emperor Conrad II. For centuries after that date it continued to be an object of strife between the Germans and Italians, until at last, in 1531, the authority of the count of Tyrol was acknowledged on all hands. Since then the city has followed the fortunes of Tyrol.

BOUCHES-DU-RHONE, a department of France, situated along the south coast, and, as the name imports, at the mouth of the Rhone. It is bounded on the N. by Vaucluse, from which it is separated by the Durance; on the E. by Var, and W. by Gard; and its area is estimated at 1963 English square miles. The western portion consists of a low and marshy plain, known as the Camargue, which is remarkable for its unhealthiness; to the east of this is situated the remarkable stretch of country called the Crau, which is strewn with pebbles like the sea beach; and further east and north there are various ranges of mountains of moderate elevation belonging to the Alpine system. A few small tributaries of the Rhone and the Durance and a number of streams, such as the Arc, the Touloubre, and the Huveaune, which find their way directly to the sea, are the only rivers that properly belong to the department. The proportion of arable land is exceedingly small, though the quantity has been considerably increased by artificial irrigation. Wheat is cultivated with success in some parts of the Camargue, and, if labour were more easily obtainable, rice might also be grown. Horses and cattle are reared in a half wild condition, and large flocks of sheep are pastured during the winter on the herbage that springs up among the pebbles of the Crau. The numbers of domestic animals in the department were in 1872 as follows:—horses 20,665, cattle 2686, sheep 262,566, and goats 17,560. The only mineral furnished to any extent by the department is coal, in the mining of which between 1000 and 2000 workmen are engaged, but there are also quarries of limestone, sandstone, slate, gypsum, marl, and marble. The salt marshes, which cover an area of 2290 acres, employ more workmen than the coal-mines, and the amount of salt obtained exceeds in quantity the produce of any other department in France. There are extensive manufactures of soaps, perfumes and oils, soda, sulphur, sugar, woollen hosiery, and leather, and a variety of other articles. The foreign commerce of the department, which is principally carried on in the Mediterranean basin, is for the most part concentrated in the capital, Marseilles; the minor ports are Martigues, Cassis, and Ciotat. The department is divided into the three arrondissements of Marseilles, Aix, and Arles; the more important towns in which (in addition to their capitals) are respectively Aubagne, Ciotat, and Roquevaire; Martigues, Salon, and Istres; and Tarascon, Saint Remy, and Châteaurenard. Among the numerous men of mark belonging to Bouches-du-Rhone are D'Urfé, Massillon, Vanloo, Tournefort, Barthélemy, Vauvenargues, Thiers, Mignet, Achard, and Reinaud. The population, which in 1872 amounted to 554,911, contains a large proportion of foreigners, mostly of Italian nationality. The total alien element in 1872 was represented by 42,855, the Italian by 33,500.

BOUFARIK (the "Hanging Well"), a town of Algeria, in the province of Algiers and arrondissement of Blidah, about 21 miles from the city of Algiers near the railway thence to Blidah. It is a thoroughly French town, and only dates from 1835, when General Drouet d'Erlon established an entrenched camp on what was then a mere hillock in the midst of an almost uninhabitable marsh. Shortly after Marshal Clausel determined to build a regular city, which was at first called Medina Clausel in his honour. The draining of the site and neighbourhood was a costly undertaking, and was only accomplished by the sacrifice of many lives. The town is now one of the most flourishing in the country, is surrounded by vast orchards and farms, and affords a market to the pastoral Arabs of the Metidja. There are flax-dressing and spinning mills, and the manufacture of essences and perfumes is carried on to a considerable extent. The population, which is composed of very various elements, amounted in 1872 to 2588.

BOUFLERS, LOUIS FRANÇOIS, DUC DE, commonly called the Chevalier Bouflers, a peer and marshal of France, and a general of distinguished reputation, was born January 10, 1644. Having early entered the army, he was raised in 1669 to the rank of colonel of dragoons. In the conquest of Lorraine he served under Marshal de Créquy. In Holland he served under Turenne, frequently distinguishing himself by his skill and bravery; and when that celebrated leader was killed by a cannon-shot in 1675, he commanded the rear-guard during the retreat of the French army. After performing various military services in Germany, in Flanders, and on the frontiers of Spain, he was created, in 1690, general of the army of the Moselle, and contributed materially to the victory of Fleurus. In the following year he acted as lieutenant-general, under the king in person; and during the investment of Mons, he was wounded in an attack on the town. He conducted the bombardment of Liége, which was defended by an enemy superior in numbers, and afterwards forced the allied generals to abandon Luxembourg. He was entrusted with the command against King William at the siege of Namur, and took part in the victory of Steinkirk. For these important services he was raised in 1693 to the rank of marshal of France, and in 1695 was made a duke. In 1694 he was appointed governor of French Flanders and of the town of Lille. By a skilful manœuvre he threw himself into Namur in 1695, and obstinately held out for four months during which the besiegers lost 20,000 men. In the conferences which terminated in the peace of Ryswick he had a principal share. During the following war, when Lille was again threatened with a siege by the duke of Marlborough and Prince Eugene, Bouflers was appointed to the command, and made an obstinate resistance of four months. He was rewarded and honoured by the king for his defence of Lille, as if he had been victorious. It was indeed a species of triumph; his enemy, appreciating his merits, allowed him to dictate his own terms of capitulation. When the affairs of France were threatened with the most urgent danger, Bouflers offered to serve under his junior, Villars, and was with him at the battle of Malplaquet. Here he again displayed his military skill, by conducting th[illegible]

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In 1755 he was sent to London as secretary to the French embassy, and was chosen a member of the Royal Society. In 1756 he went to Canada as captain of dragoons and aide-de-camp to the marquis of Montcalm; and having distinguished himself in the war against England, was rewarded with the rank of colonel and the cross of St Louis. He afterwards served in the Seven Years' War from 1761 to 1763. After the peace, when the French Government conceived the project of colonizing the Falkland Islands, Bougainville undertook the task at his own expense. But the settlement having excited the jealousy of the Spaniards, the French Government gave it up to them, on condition of their indemnifying Bougainville. He was then appointed to the command of the frigate "La Boudeuse" and the transport "L'Étoile," on a voyage of discovery round the world. He set sail from Nantes in November 1766, taking with him Commerçon as naturalist, and Verron as astronomer. Having executed his commission of delivering up the Falkland Islands to the Spanish, Bougainville proceeded on his expedition, and touched at Buenos Ayres. Passing through the Straits of Magellan, he anchored at Otaheite, where the English navigator Wallis had touched eight months before. The expedition having crossed the Pacific Ocean, and the men now suffering from scurvy, the ships came to anchor off the Island of Boron, one of the Moluccas, where the governor of the Dutch settlement supplied their wants. It was the beginning of September, and the expedition took advantage of the easterly monsoon, which carried them to Batavia. Thence they proceeded to the Isle of France, where they left Commerçon and Verron. In 1769 the expedition arrived at St Malo, after a voyage of two years and four months, with the loss of only seven out of upwards of 200 men. Bougainville's account of the voyage (Paris, 1771, 4to) is written with simplicity and with some humour. The art of making astronomical observations at sea was then much less perfect than now, and, consequently, Bougainville's charts are found to be erroneous, particularly as to the longitudes. After an interval of several years, he again accepted a naval command and saw much active service between 1779 and 1782. In the memorable engagement of April 12, 1782, in which Rodney defeated the Count de Grasse, near Martinique, Bougainville, who commanded the "Auguste," succeeded in rallying eight ships of his own division, and bringing them safely into St Eustace. After the peace he returned to Paris, and solicited and obtained the place of associate of the Academy. He projected a voyage of discovery towards the north pole, but this did not meet with support from the French Government. Bougainville obtained the rank of vice-admiral in 1791; and in 1792, having escaped almost miraculously from the massacres of Paris, he retired to his estate in Normandy. He was chosen a member of the Institute at its formation; and then returning to Paris succeeded Borda as member of the Board of Longitude. In his old age Napoleon I. made him a senator, count of the empire, and member of the Legion of Honour. He died at Paris, August, 31, 1814. He was married and had three sons, who served in the French army. His *éloge*, composed by Delambre, appears in the *Memoirs of the Institute*.

BOUGIE, or BOUGIAH, a fortified seaport town of Algeria, in the province of Constantine and arrondissement of Sétif, betweeen Cape Carbon and the Wady-Sahell. Among its more important buildings are the French church, the hospital, the barracks, the magazines, and the Abd-el-Kader fort, now used as a prison. Trade is carried on in wax, grain, oranges, oil, and wine. A basin was constructed about 1870 in the anchorage below the town. The population in 1872 was 2820, of whom 1134 were natives. Bougie, Bugia, or Bugiah is a town of great antiquity. If it is correctly identified with the *Salda* of the Romans it probably owes its origin to the Carthaginians. Genseric, the king of the Vandals, surrounded it with walls and chose it as his capital for some time; and in the 10th century it became, under the Beni-Hammad, the greatest commercial city of the North African coast. The Italian merchants of the 12th and 13th centuries had numerous buildings of their own in the city, such as warehouses, baths, and churches. It became a haunt of pirates in the 15th century, and in the beginning of the 16th it was captured by the Spaniards, from whom it was taken by the Turks in 1555. It was a place of little importance when it fell into French possession about 1833.

BOUGUER, PIERRE, an eminent French mathematician, was born in 1698. His father, one of the best hydrographers of his time, was regius professor of hydrography at Croisic in Lower Britanny, and author of an excellent treatise on navigation. Young Bouguer was bred to mathematics from his infancy, and at an early age was appointed to succeed his father as professor of hydrography. In 1727 he gained the prize given by the Academy of Sciences for his paper "On the best manner of forming and distributing the Masts of Ships;" and two other prizes, one for his dissertation "On the best method of observing the Altitude of Stars at Sea," the other for his paper "On the best method of observing the Variation of the Compass at Sea." These are published in the *Prix de l'Académie des Sciences*. In 1729 he published *Essai d'optique sur la gradation de la lumière*, the object of which is to define the quantity of light lost by passing through a given extent of the atmosphere. He found the light of the sun to be 300 times more intense than that of the moon. He was soon after made professor of hydrography at Havre, and succeeded Maupertuis as associate geometer of the Academy of Sciences. He was afterwards promoted in the Academy to the place of pensioned astronomer, and went to reside in Paris. In 1735 Bouguer sailed with Godin and De la Condamine for Peru, in order to measure a degree of the meridian near the equator. Ten years were spent in this operation, a full account of which was published by Bouguer in 1749, *Figure de la Terre determinée*. His later writings were nearly all upon the theory of navigation. He died in 1758.

The following is a list of his principal works:—*Traité d'optique sur la gradation de la lumière*, 1729 and 1760; *Entretiens sur la cause d'inclinaison des orbites des planètes*, 1734; *Traité de navire*, &c., 1746, 4to; *La Figure de la terre determinée*, &c., 1749, 4to; *Nouveau traité de navigation, contenant la théorie et la pratique du pilotage*, 1753; *Solution des principaux problèmes sur la manœuvre des Vaisseaux*, 1757; *Opérations faites pour la verification du degré du méridien entre Paris et Amiens*; par Mess. Bouguer, Camus, Cassini, et Pingré, 1757.

BOUHOURS, DOMINIQUE, a French critic, was born at Paris in 1628. He entered the Society of the Jesuits at the age of sixteen, and was appointed to read lectures on literature in the college of Clermont at Paris, and on rhetoric at Tours. He afterwards became preceptor to the two sons of the duke of Longueville. The duke died in Bouhours's arms; and the "account of the pious and Christian death" of this great personage was his first publication. He was sent to Dunkirk to the Romanist refugees from England, and in the midst of his missionary occupations published several books. Among these were *Les Entretiens d'Ariste et d'Eugène*, a work of a critical nature on the French language, printed five times at Paris, twice at Grenoble, and afterwards at Lyons, Brussels, Amsterdam, Leyden, &c. It involved him in numerous quarrels particularly with Ménage, who, however, continued to live on friendly terms with the author. The fame and [illegible] this piece recommended Bouhours so eff[illegible] great Colbert, that he intrusted him wit[illegible]

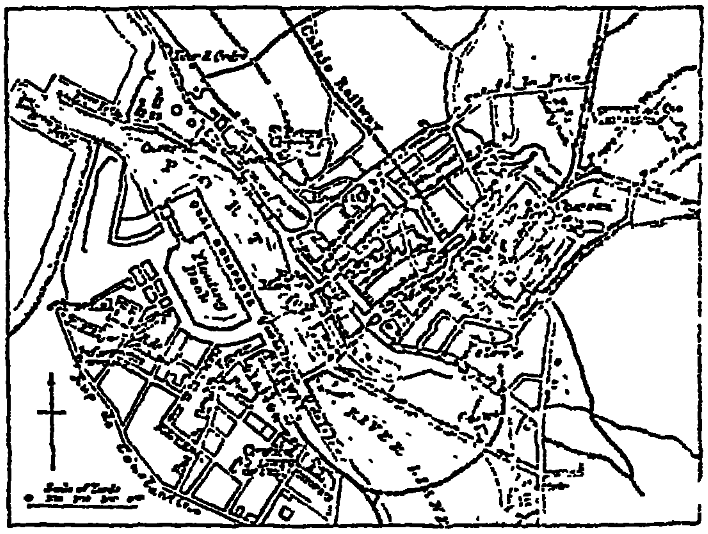
his son the marquis of Seignelay. He afterwards wrote several other works in French, the chief of which are, *La Manier de bien penser sur les ouvrages d'esprit*, 1687; *Remarks and Doubts upon the French Language*, 1694; *The Life of St Ignatius*, 1679; *The Art of Pleasing in Conversation; The Life of St Francis Xavier*, 1682. It was his practice to publish alternately a book on literature and a work on some subject of piety, which gave occasion to a wag, in a satirical epitaph, to remark of him, "qu'il servait le monde et le ciel par semestre." His *Pensées ingenieuses des Anciens et des Modernes*, though at once instructive and amusing, exposed him to censure as well as ridicule, on account of some strange misjudgments and omissions. He has classed Boileau with the least esteemed of the Italian satirical versifiers, and has omitted, in his *Thoughts on the Moderns*, all mention of Pascal,—a circumstance which is doubtless to be explained by his being a disciple of St Ignatius, who, it may be supposed, would willingly forget the author of the *Provincial Letters*. Bouhours died at Paris in 1702.

BOUILLON, Godfrey de, one of the foremost leaders in the first crusade, was born at Baisy, near Gemappe in Belgium, about 1060. His father was Eustace II., count of Bouillon in the Ardennes; and through his mother Ida, daughter of Godfrey, duke of Lower Lorraine, he could claim descent from Charlemagne. In the contest between Henry IV., emperor of Germany, and Hildebrand, he espoused the imperial cause, and was the first to scale the walls of Rome when the emperor's forces besieged that city in 1084. In reward for his services Henry invested him with the titles of marquis of Antwerp and duke of Lorraine. It is said that while suffering from fever, having heard of the preparations for the first crusade, he vowed, were his health restored, to seek Palestine; "whereupon," says William of Malmesbury, "he shook disease from his limbs, and shone with renovated beauty." Having pawned his lordship of Bouillon to the church of Liége for 1300 marks, he gathered around him 80,000 infantry and 10,000 horsemen, whom he led with rare ability through Germany to the borders of Hungary, where he shamed his brother Baldwin by offering to go in his stead as a hostage to the Hungarians. On arriving in 1096 at Constantinople, he obtained the release of his fellow-crusader Hugh of Vermandois from the wily Greek emperor Alexius, and in the strife which that monarch's duplicity fomented evinced the sagacity and promptitude of a great general. After capturing Antioch and routing a vast Saracen host at Dorylæum in Phrygia, the crusaders arrived, in 1099, at Jerusalem, which was taken after a siege of five weeks, Godfrey entering the breach among the foremost, but tarnishing his glory by ruthlessly ordering a massacre of the infidels. A Christian kingdom of Jerusalem was then founded, of which Godfrey was unanimously elected sovereign; but he refused to wear a crown of gold where his Lord had worn a crown of thorns, and accepted, instead of the kingly title, the humbler designation of defender and baron of the Holy Sepulchre. During the single year of his rule he repelled the Saracens with admirable courage and skill, routing the Fatimite caliph of Egypt at Ascalon, and with the assistance of others of the pilgrims, drew up from the various feudal statutes of Europe the elaborate system of mediæval jurisprudence known as the *Assizes of Jerusalem*. Godfrey died in 1100, and was buried in the church of the Holy Sepulchre; and so impartial and temperate had been his rule, that Mahometans as well as Christians bewailed his loss. He combined the favourite virtues of his age; and his exploits, in the quaint words of Gregory de Vinsauf, "were as food in the mouths of their narrators." He was as accomplished as brave, and could speak the Latin and Teutonic languages with equal ease. Tasso, in the *Gerusalemme Liberata*, makes Godfrey the equal of Tancred in the field and of Raymond in the council, and seems scarcely to have exaggerated his heroism and skill in war, his piety, wisdom, and purity of life.

BOULAINVILLIERS, Henri de, Lord of St Saire, an eminent French writer, descended from a very ancient and noble family, was born at St Saire in Normandy in 1658. He received his education at the college of Juilli, where he early discovered the uncommon abilities for which he was afterwards distinguished. His historical writings are numerous and important, but deformed by an extravagant admiration of the feudal system, which he regarded as the *chef d'œuvre* of the human mind. He misses no opportunity of regretting those "good old times," when the people were enslaved by a few petty tyrants alike ignorant and barbarous. His philosophical writings have now lost all their value. His pretended *refutation* of the system of Spinoza is a weak and imperfect exposition of that writer's opinions. He died at Paris in 1722.

His principal works (all published after his death) are—*Histoire de l'ancien gouvernment de la France*, &c., La Haye, 1727, 3 tom. 8vo; *État de la France, avec des mémoires sur l'ancien gouvernment*, &c., Lond., 1727, 3 tom. fol.; *Histoire de la Pairie de France*, &c., Lond., 1753; *La Vie de Mahomet* (a "Fable of Mahomet," as Mosheim calls it); *Histoire des Arabes*, Amst. (Paris), 1731, 2 vols. 12mo.

BOULOGNE SUR MER, a fortified seaport of France, and the chief town of an arrondissement in Pas-de-Calais,



Plan of Boulogne.

1, 2, 3. Etablissement,—Including Baths, Aquarium, and Skating Rink.
4. Place Navarin.
5. Rue Wissocq.
6. Cathedral.
7. Palais de Justice
8. Mairie.
9. Convent (Annonciades).
10. Place Godefroi.
11. Porte Gayole.
12. Sous-Préfecture
13. College
14. Museum.
15. St Nicholas Church.
16. Market House.
17. Theatre.
18. English Church.
19. Place St Sauveur

Dame, built (1827–1866) on the site of an old building destroyed in the Revolution, having underneath an extensive crypt which still remains. The New Town extends from the foot of the hill to the harbour and along the shore, and contains several good streets, some of which are, however, very steep. A main street, named successively Rue de la Lampe, St Nicholas, and Grande Rue, extends from the bridge across the Liane (near the railway station) to the promenade by the side of the ramparts and the Hôtel de Ville. This is intersected first by the shore-way named *Quai de la Flotille*, *Quai de la Victoire*, &c. (where there are numerous hotels), and further back by the Rue Napoléon and Rue Royale, the principal business part of the town, and where the best shops are situated. The principal buildings comprise a museum, formerly the great seminary, a hospital, a theatre, an elegant *établissement* (opened in 1863, containing ball-room, reading-room, &c.), a custom-house, barracks, various churches and convents, and a fish-market. Connected with the museum is a public library with 30,000 volumes and a large number of very valuable manuscripts, many of them richly illuminated. Boulogne has for a long time been one of the most Anglicized of French cities; and in the tourist season a continuous stream of English travellers reach the Continent at this point. There is regular steamboat service between the port and Folkestone, the average passage occupying 2¼ hours, or about three-quarters of an hour longer than from Calais to Dover. There are two English chapels in the town, and numerous boarding-schools intended for English pupils. Churchill, who died while on a visit to his friend Wilkes, in 1765, is buried in the cemetery, and the house is pointed out where Thomas Campbell expired in 1843. The shore is lined with extensive flat sands, where bathing is facilitated by the use of machines. Among the objects of interest in the neighbourhood the most remarkable is the Napoleon column or Colonne de la Grande Armée, erected on the high ground above the town, in honour of Napoleon I., on occasion of the projected invasion of England, for which he here made great preparations. The pillar, which is of the Doric order, 166 feet high, is surmounted by a statue of the emperor by Bosio. Though commenced in 1804, the monument was not completed till 1841. On the edge of the cliff to the east of the port are some rude brick remains of an old building called Tour d'Ordre, said to be the ruins of a tower built by Caligula at the time of his intended invasion of Britain. The entrance to the harbour of Boulogne, which is tidal, is formed by two long piers running out from the mouth of the river, and serving during fine weather as excellent promenades. On the western side is the basin excavated by Napoleon for his flotilla of flat-bottomed boats in 1804. A large wet dock, constructed at a cost of upwards of £250,000, was opened in 1872, and adds greatly to the facilities of the port, its area being 17 acres and the length of its quay-wall 1150 yards. The depth of water in the harbour is 23 feet at spring-tide and nearly 20 at neap-tide; in the sluice of the floating basin the numbers are 29½ and 23½ respectively. The foreign commerce of Boulogne, which is almost wholly carried on in British ships, consists chiefly in the importation of manufactured goods, jute, silk, Australian wool, coal, machinery, hardwares, paper-hangings, malt, beer, and chemicals; and the exportation of wine, brandy, eggs, artificial flowers, haberdashery, and musical instruments. The total value of the exports in 1871 was £12,709,675, and of the imports £11,762,500. How rapid the development of the commerce with Britain has been may be seen from the fact, that while in 1840 the British sailing vessels thus engaged amounted only to 66, and the steam-ships to 678, in 1860 the corresponding numbers were 341 and 863, and in 1871, 541 and 1061. In the extent and value of its fisheries Boulogne is exceeded by no seaport in France. The most important branch is the herring-fishery, which is prosecuted northwards along the shores of Scotland; next in value is the mackerel fishery, and next again the Iceland cod. Large quantities of fresh fish are transmitted to Paris by railway, but an abundant supply is reserved to the town itself. The fishermen live for the most part in a separate quarter called La Beurière. Among the numerous industrial establishments in Boulogne and its environs may be mentioned several foundries, with blast-furnaces, cement-manufactories, flax-mills, steam saw-mills, steel-pen manufactories, carriage-works, tile-works, and a fishing-net factory. Shipbuilding is also carried on to some extent. The population of the town, which in 1821 was 16,607, amounted by the census of 1872 to 39,700.

Boulogne is usually, though on somewhat dubious grounds, identified with the *Gesoriacum* of the Romans. At an early period it began to be known as *Bononia*, a name which has been gradually modified into the present form. The town was destroyed by the Normans in 882, but restored about 912. From about that time till 1477 it was the head of a separate countship, which was united to the crown of France by Louis XI., who ingeniously recognized the Holy Virgin as the superior, and declared himself her vassal. In 1544 Henry VIII.—more fortunate in this than Henry III. had been in 1347—took the town by siege; but it was restored to France in the following reign.

BOULTON, Matthew, manufacturer and practical engineer, was born at Birmingham on the 14th of September 1728. He was called early into active life upon the death of his father in 1745, and soon found ample scope for the exercise of his inventive faculties in improving the manufactures of his native place. His first attempt was a new mode of inlaying steel; and he succeeded in obtaining a considerable demand for the products of his manufactory, which were principally exported to the Continent, and not uncommonly re-imported for domestic use as of foreign manufacture.

In 1762, his fortune being already considerable, he purchased a tract of barren heath in the neighbourhood of Birmingham, with a single house on it, and there founded, at the expense of £9000, the manufactory which flourished so long and was so well known under the name of Soho. His workmen were at first principally employed in the imitation of ormolu, and in copying oil paintings with great accuracy, by means of a mechanical process which was invented by a Mr Eggington, who afterwards distinguished himself by various works in stained glass. Boulton finding the horse-power inadequate to the various purposes of his machinery erected, in 1767, a steam-engine, upon the original construction of Savary, which, notwithstanding the inconvenience of a great loss of steam from condensation, by its immediate contact with the water raised, has still some advantages from the simplicity of the apparatus it requires, and has been found to succeed well upon a small scale. But Boulton's objects required a still more powerful machine, and he had the discernment to perceive that they might be very completely attained by the adoption of the various improvements made in the steam-engine by James Watt of Glasgow, who had obtained a patent for them in 1769, the privileges of which were extended in 1775, by an Act of Parliament, to a term of twenty-five years. Boulton induced the great inventor to remove to Birmingham. They commenced a partnership in business, and established a manufactory of steam-engines, in which accurate execution kept pace so well with judicious design, that its productions continued to be equally in request with the public after the expiration of

the term of that legal privilege which at first gave the proprietors the exclusive right of supplying them, and which had been confirmed in 1792 by a decision of the Court of King's Bench against some encroachment on the right of the patentee. It was principally for the purpose of carrying on this manufactory with greater convenience, that the proprietors established an iron-foundry of their own at Smethwick, in the neighbourhood of Soho.

In 1785 Boulton was made a fellow of the Royal Society, about the same time with Withering, and several others of his scientific neighbours. In 1788 he turned his attention to the subject of coining, and erected machinery for the purpose, so extensive and complete, that the operation was performed with equal economy and precision, and the coins could not be imitated by any single artist for their nominal value,—each of the stamps coining, with the attendance of a little boy only, about eighty pieces in a minute. The preparatory operation of laminating and cutting out the metal was performed in an adjoining room; and all personal communication between the workmen was rendered unnecessary by the mechanical conveyance of the work from one part of the machinery to another. A coinage of silver was executed at this mint for the Sierra Leone Company, and another of copper for the East Indies, besides the pence and half-pence at one time in circulation throughout England, and a large quantity of money of all kinds for Russia. In acknowledgment of Boulton's services, and in return for some specimens of his different manufactures, the Emperor Paul made him a present of a valuable collection of medals and minerals.

In 1797 he obtained a patent for a mode of raising water by impulse, the specification of which is published in the ninth volume of the *Repertory of Arts*, p. 145. It had been demonstrated by Daniel Bernouilli, in the beginning of the century, that water flowing through a pipe, and arriving at a part in which the pipe is suddenly contracted, would have its velocity at first very greatly increased; but no practical application of the principle appears to have been attempted, until an apparatus was set up in 1792 by Mr Whitehurst for Mr Egerton of Oulton, in Cheshire, consisting of an air-vessel communicating with a water-pipe by a valve, which was forced open by the pressure or rather impulse of the water, when its passage through the pipe was suddenly stopped by turning the cock in the ordinary course of domestic economy; and although the pipe through which the water was forced up was of moderate height, the air-vessel, which was at first made of lead, was soon burst by the "momentous force," as Whitehurst termed it. The apparatus had excited much attention in France, under the name of Montgolfier's hydraulic ram; and Boulton added to it a number of ingenious modifications, some of which, however, are more calculated to display the vivid imagination of a projector than the sound judgment of a practical engineer, which had in general so strongly characterized all his productions.

He died, August 17, 1809, after a long illness, in possession of considerable affluence and of universal esteem. (See Smiles's *Lives of Boulton and Watt*, 1865.)

BOURBON. The noble family of Bourbon, from which so many European kings have sprung, took its name from the rich district in the centre of France, called the *Bourbonnais*, which in the 10th century was one of the three great baronies of the kingdom. The first of the long line of Bourbons known in history was Adhémar or Aimar, who was invested with the barony towards the close of the 9th century. In 1272 Beatrix, daughter of Agnes of Bourbon and her husband John of Burgundy, married Robert, count of Clermont, sixth son of Louis IX. (St Louis) of France. The elder branches of the family had become extinct, and their son Louis became duc de Bourbon in 1327. In 1488 the line of his descendants ended with Jean II., who died in that year. The whole estates passed to Jean's brother Pierre, lord of Beaujeu, who was married to Anne, sister of Louis XI. Pierre died in 1503, leaving only a daughter, Suzanne, who, in 1505, married Charles de Montpensier, heir of the Montpensier branch of the Bourbon family. Charles, who took the title of duc de Bourbon on his marriage, was born in 1489, and at an early age was looked upon as one of the finest soldiers and gentlemen in France. His union with Suzanne made him the wealthiest and most powerful French noble; and after his brilliant successes in Italy and France, he became an object of dread to Louis XII., who would not give him the command of the army of Italy. In 1515 Francis I., on his accession, made Bourbon constable of France, and in that capacity he gained new honours, and was for a time in the highest favour with the king. But serious differences soon arose between them, originating, according to common report, in the violent but slighted passion of Louise, duchesse d'Angoulême, the king's mother, for the constable. The grossest insults were heaped upon Bourbon; his official salary and the sums he had borrowed for his war expenses remained unpaid; in the campaign against Charles V. the command of the vanguard was given to the duc d'Alençon; and after the death of Suzanne de Bourbon, an action was raised by the queen dowager, who claimed to be nearest heir. In defiance of Bourbon's marriage-settlement, judgment was given against him, and he was reduced to absolute beggary. Smarting under these wrongs he entered into negotiations with Charles V., and on these coming to the knowledge of Francis at once fled from his native country and joined the emperor. He did good service in the war against his countrymen, and especially distinguished himself at the battle of Pavia, where his ungenerous sovereign Francis was taken prisoner. Bourbon, however, did not find Charles very ready to fulfil his various promises, and determined to seize a kingdom for himself. With the division under his command he penetrated into Italy, and on the 5th May 1527 appeared before the walls of Rome. In the assault on the following morning he was the first to mount the walls, and fell mortally wounded by a pistol-shot, fired, it is said, by Benvenuto Cellini. His army succeeded in taking and sacking the town. With the constable ended the direct line from Pierre, duc de Bourbon. But the fourth in descent from Pierre's brother, Jacques, Louis, count of Vendôme and Chartres, became the ancestor of the royal house of Bourbon and of the noble families Condé, Conti, and Montpensier. The fourth in direct descent from Louis of Vendome was Antoine de Bourbon, who in 1548 married Jeanne d'Albret, heiress of Navarre, and who became king of Navarre in 1554. Their son became king of France, with the title Henri IV. Henri was succeeded by his son Louis XIII., who left two sons, Louis XIV., and Philippe, duc d'Orleans, head of the Orleans branch. Louis XIV.'s son, the Dauphin, died

Philippe, has descended another claimant of the throne. Philippe's son was the Regent Orleans, whose great grandson, Philippe Egalité, perished on the scaffold in 1793. Egalité's son, Louis Philippe, was king of France from 1830 to 1848; his grandson, Louis Philippe (born 1838), is the present Comte de Paris.

Spanish Branch.—Philippe, duc d'Anjou, grandson of Louis XIV., became king of Spain as Philip V. in 1700. He was succeeded in 1746 by his son Ferdinand VI., who died in 1759 without family, and was followed by his brother Charles III. Charles III.'s eldest son became Charles IV. of Spain in 1788, while his second son, Ferdinand, was made king of the Two Sicilies in 1759. Charles IV. was deposed by Napoleon, but in 1814 his son, Ferdinand VII., again obtained his throne. Ferdinand was succeeded by his daughter Isabella, who in 1870 abdicated in favour of her son Alphonso, at present (1876) in possession of the Spanish kingdom. Ferdinand's brother, Don Carlos (died 1855), claimed the throne in 1833 on the ground of the Salic law, and a fierce war raged for some years in the north of Spain. His son Don Carlos, count de Montemolin (born 1818, died 1861) revived the claim, but was defeated and compelled to sign a renunciation. The nephew of the latter, Don Carlos Maria Juan Isidor (born 1848), has been for some years carrying on war in Spain with the object of attaining the rights contended for by the Carlist party.

Neapolitan Branch.—The first Bourbon who wore the crown of Naples was Charles III. of Spain, who on his succession to the Spanish throne in 1759, resigned his kingdom of Naples to his son Ferdinand. Ferdinand was deposed by Napoleon, but afterwards regained his throne, and took the title of Ferdinand I., king of the Two Sicilies. In 1825 he was succeeded by his son Francis, who in turn was succeeded in 1830 by his son Ferdinand II. Ferdinand II. died in 1859, and in the following year his successor Francis II. was deprived of his kingdom, which was incorporated into the gradually-uniting Italy.

Duchies of Lucca and Parma.—In 1748 the duchy of Parma was conferred on Philip, youngest son of Philip V. of Spain. His grandson, Charles Louis Ferdinand, became king of Etruria in 1801, but was deprived of his possessions by the French. In 1847, however, he received the duchies of Parma and Piacenza on the death of his mother, but after two years abdicated in favour of his son, Charles III. Charles III. married the daughter of the duc de Berri, and was assassinated in 1854. His son was proclaimed duke, but the territories of Parma and Piacenza were seized by Victor Emanuel in 1859–60.

Coiffier de Moret, *Histoire du Bourbonnais et des Bourbons*, 2 vols. 1824; Berand, *Histoire des sires et ducs de Bourbon*, 1835; Désormeaux, *Histoire de la maison de Bourbon*, 5 vols., 1782–88; Achaintre, *Histoire généalogique et chronologique de la maison royale de Bourbon*, 2 vols., 1825–6.

BOURBON, an island off the east coast of Africa, now known as Réunion. See Réunion.

BOURBON-L'ARCHAMBAULT (the *Aqua Bormonis* of the Itineraries), a town of France, in the department of the Allier, on the Burge, 19 miles W. of Moulins. It was anciently the capital of the Bourbonnais, and gave its name to the great Bourbon family. Its mineral waters, both hot and cold, were formerly in high repute. In 1789 it changed its name for that of *Burges-les-Bains*, but the former designation was afterwards resumed. It contains a Gothic church of the 12th century, and the outer walls and towers of a castle finished by Anne of Beaujeu in the 15th. Population in 1872, 2400.

BOURBON-VENDÉE, or Napoleon Vendée, a town of France, capital of the department of La Vendée, now called La Roche sur Yon, which see.

BOURBONNE-LES-BAINS, a town of France, in the department of Haute-Marne, in the arrondissement of Langres, and 21 miles E.N.E. of that town. It is much frequented on account of its hot saline springs, which are found on the site of the old Roman baths. The heat of these springs varies from 120° to 156° Fahr. The number of visitors is upwards of 800 annually. The principal buildings are a church of the 13th century, the town-house, and the hospital; there are also the remains of a castle and a priory. The manufacture of beet-root sugar is carried on in the town, and gypsum and alabaster are quarried in the neighbourhood. Population in 1872, 4038.

BOURCHIER, John, Lord Berners, born about 1474, was grandson and heir of a lord of the same name, who was descended from Thomas of Woodstock, duke of Gloucester, and had been knight of the Garter and constable of Windsor Castle. He was educated at Oxford, and was created a Knight of the Bath on the marriage of the duke of York, second son of Edward IV. He was first known by quelling an insurrection in Cornwall and Devonshire, raised by Michael Joseph, a blacksmith, in 1495, which service recommended him to the favour of Henry VII. He was a captain of the pioneers at the siege of Therouanne under Henry VIII., by whom he was made chancellor of the exchequer for life, and lieutenant of Calais and the Marches. He was appointed to conduct Mary, the king's sister, into France on her marriage with Louis XII., and had the extraordinary fortune of continuing in favour with Henry VIII. for the space of eighteen years. He died at Calais in 1532, aged 65. By king Henry's command he translated Froissart's *Chronicle*, which was printed in 1523 and 1525 by Pynson, the scholar of Caxton. His other works consisted of translations from French, Spanish, and Italian novels. These were, the *History of the most Noble Valyaunt Knyght, Arthur of Lytell Brytayne; the Famous Exploits of Sir Hugh of Bourdeaux; the Golden Boke of Marcus Aurelius;* and *the Castle of Love.* He composed also a book on the duties of the inhabitants of Calais, and a comedy entitled *Ite in Vineam*, which used to be acted at Calais after vespers.

BOURDALOUE, Louis, a celebrated preacher, and one of the greatest orators that France has ever produced, was born at Bourges, August 20, 1632. At the age of sixteen he entered the Society of Jesus, of which he was destined to become one of the greatest ornaments, and there completed his studies. His able masters, who early discerned his talents, successively confided to him the chairs of humanity, of rhetoric, of philosophy, and of moral theology; and it was only after passing through these different probationary employments that he arrived at the eminent post which was designed for him, and was deemed qualified for mounting the pulpit.

In order to form an idea of the difficulties which he had to surmount, and of the talents which he displayed, it is only necessary, on the one hand, to call to mind the ridiculous manner and inflated style of the preachers of that period; and on the other, to figure the young Jesuit at issue with the bad taste as well as the bad habits of the time,—combating at once the passions, the vices, the weaknesses, and the errors of humanity, and overcoming his enemies, sometimes with the arms of faith, and sometimes with those of reason.

At first he preached for some time in the provinces, but his superiors afterwards called him to Paris. This took place in 1669, at the most brilliant epoch of the age of Louis XIV., when nothing was talked of but the victories of Turenne, the festivities of Versailles, the masterpieces of Corneille and Racine, the encouragement afforded to the arts, and the general impulse given to the human mind. Bourdaloue suddenly appeared in the midst of these fasci-

nations, and, far from diminishing their effects, the severity of his ministry and the gravity of his eloquence served rather to enchance their splendour. His first sermons met with prodigious success, and all voices were raised in loud applause of the preacher. Madame de Sevigné, sharing the universal enthusiasm, wrote to her daughter that "she had never heard anything more beautiful, more noble, more astonishing, than the sermons of Father Bourdaloue." Louis XIV. also wished to hear him, and the new preacher was in consequence sent to court, where he preached during Advent in 1670, and during Lent in 1672; and he was afterwards called for the Lents of 1674, 1675, 1680, and 1682, and for the Advents of 1684, 1689, and 1693. This was a thing unheard of before, the same preacher being rarely called three times to court. Bourdaloue, however, appeared there ten times, and was always received with the same ardour. Louis XIV. said that "he loved better to hear the repetitions of Bourdaloue than the novelties of any one else." After the revocation of the Edict of Nantes he was sent to Languedoc to preach to the Protestants, and confirm the newly-converted in the Catholic faith; and in this delicate mission he managed to reconcile the interests of his ministry with the sacred rights of humanity. He preached at Montpellier in 1686 with the greatest success, Catholics and Protestants being all equally eager to recognize in this eloquent missionary the apostle of truth and of virtue.

In the last years of his life Bourdaloue abandoned the pulpit, and devoted himself to charitable assemblies, hospitals, and prisons, where his pathetic discourses and conciliatory manners were very effective. He had the art of adapting his style and his reasonings to the condition and the understanding of those to whom he addressed either counsel or consolation. Simple with the simple, erudite with the learned, and a dialectician with sophists and disputants, he came off with honour in all the contests in which zeal for religion, the duties of his station, and love of mankind led him to engage. Equally relished by the great and by the commonalty, by men of piety, and by people of the world, he exercised till his death in 1704 a sort of empire over all minds; and this ascendency he owed as much to the gentleness of his manners as to the force of his reasoning. "His conduct," says one of his contemporaries, "is the best answer that can be made to the *Lettres Provinciales*." No consideration was ever capable of altering his frankness or corrupting his probity.

Bourdaloue may with justice be regarded as the reformer of the pulpit and the founder of Christian eloquence among the French. That which distinguishes him from other preachers is the force of his reasoning, and the solidity of his proofs. Never did Christian orator infuse into his discourses more majesty, dignity, energy, and grandeur. Like Corneille, he has been charged with overlabouring his diction, and accumulating idea upon idea with a needless superfluity of illustration—of speaking more to the understandings than to the hearts of his auditors, and sometimes enervating his eloquence with the too frequent use of divisions and subdivisions. But even in subscribing to these criticisms, which are to a certain extent well founded, it is impossible not to admire the inexhaustible fecundity of his plans—the happy talent *velut imperatoria virtus* which he possessed, of disposing his reasonings in the order best calculated to command victory—the logical skill with which he excludes sophisms, contradictions, and paradoxes—the art with which he lays the foundations of our duty in our interest—and, finally, the inestimable secret of converting the details of manners and habits into so many proofs of his subject. Parallels have often been drawn between Bourdaloue and Massillon; but the talents of these great pulpit orators lay in different directions, and they may, therefore, be more fitly contrasted than compared. "Between Massillon and Bossuet," says Lord Brougham, whose judgment of Bossuet errs, however, on the side of severity, (*Works*, vol. vii.), "and at a great distance certainly above the latter, stands Bourdaloue, whom some have deemed Massillon's superior, but of whom an illustrious critic (D'Alembert, *Éloge de Massillon*) has more justly said that it was his greatest glory to have left the supremacy of Massillon still in dispute. It is certain that he displays a fertility of resources, an exuberance of topics, whether for observation or argument, not equalled by almost any other orator, sacred or profane." If Massillon is now read with a more lively interest, he owes that advantage to the charms of his style rather than to the force of his reasoning. Among the critics of the present day, the preference is unhesitatingly given to the rival of Racine, to the painter of the heart, to the author of the discourse on the small number of the elect; but if we consult the contemporaries of Massillon himself, we shall find that they assign him only the second rank. According to them Bourdaloue preached to the men of a vigorous and masculine age—Massillon to those of a period remarkable for its effeminacy. Bourdaloue raised himself to the level of the great truths of religion—Massillon conformed himself to the weakness of the men with whom he lived. The bishop of Clermont will always be read; but if the simple Jesuit could raise his commanding voice from the tomb, and again roll forth a majestic stream of divine truth, the courtly accents of his rival would no longer be heard, and the charms of his diction would be forgotten. The first part of his celebrated *Passion*, in which he proves that the death of the Son of God is the triumph of His power, has generally been considered as the great masterpiece of Christian eloquence. Bossuet has said nothing stronger or more elevated. The second part, however, is inferior to the first, though considered by itself alike beautiful and convincing.

The discourses of Bourdaloue have been described by a celebrated French critic as embodying in them a complete course of theology. This is perhaps going a little too far; but still their general merit is very great, and for nothing are they more distinguished than their comprehensiveness. The diction of this great preacher is always natural, clear, and correct, sometimes deficient in animation, but without vacuity or languor, and generally relieved by outbreakings of much force and originality.

Two editions of Bourdaloue's works were published at

for the richness of its sculpture and carving. Two of the squares of the town are ornamented, one with a statue of Bichat by David d'Angers, and the other by an obelisk to the memory of General Joubert. The manufactures of the place consist of cloth, linen, hats, hosiery, horn combs, and pottery; and there is an active trade in grain, cattle, horses, and wine. The early history of Bourg and its identification with any of the places recorded by the Roman writers have been matters of considerable dispute. In the earlier part of the Middle Ages it seems to have been called *Tanum*. Raised to the rank of a free town in the end of the 13th century, it was afterwards chosen by Amadeus IV. of Savoy as the chief city of the province. In 1535 it passed to France, but was restored to Duke Philibert Emanuel, who in 1590 built a strong citadel, which afterwards withstood a six months' siege by the soldiers of Henry IV. The town was finally ceded to France in 1601. In 1814 the inhabitants, in spite of the defenceless condition of their town, offered resistance to the Austrians, who put the place to pillage. Vaugelas the grammarian and Lalande the astronomer were both born at Bourg-en-Bresse. Population in 1872, 12,912.

BOURGAS, BURGHAZ, or BORGAS, called in the Middle Ages Pyrgos, a seaport town of Turkey in the province of Rumelia, situated on a bay of the Black Sea, to which it gives its name, about 70 miles N.E. of Adrianople, in 42° 30′ N. lat. and 27° 30′ E. It is neatly built, and has a large public square surrounded with stalls for the accommodation of 5000 horses. Pottery and pipes are manufactured with great taste from clay obtained in the neighbourhood, and there is a considerable trade in grain, woollen stuffs, tallow, butter, cheese, rosewater, and other productions of the surrounding country. Not far distant is Litzin, a favourite summer watering-place. In 1825 the Russians besieged the town. The population is estimated at 5000.

BOURGELAT, CLAUDE, who may be called the father of veterinary science, was born at Lyons in 1712, and died in 1799. He entered the profession of law, but abandoned it in disgust at having gained an unjust suit for a client. Embracing the military profession he served in the cavalry, and thus had ample opportunity of studying the diseases of animals. In 1772 he opened at Lyons a veterinary school, which soon became celebrated over Europe. His great success induced the Government to establish several similar institutions; and Bourgelat was appointed to superintend the school established at Alfort, which became, and continues to be, the chief seat of veterinary science in France. Bourgelat was a member of the Academies of Sciences of Paris and of Berlin, and corresponded with some of the most eminent men of science of his time. His works on veterinary subjects are numerous and valuable; perhaps the most important is the *Traité de la conformation extérieure du cheval, de sa beauté et de ses défauts*, 1776.

BOURGES, a city of France, formerly the capital of the province of Berry, and now the chief town of the department of Cher, is situated about 100 miles S. of Paris, at the confluence of the Auron and Yevre, in 47° 4′ 59″ N. lat. and 2° 32′ E. long. The sixty watch-towers by which it was formerly defended have been removed, but it is still surrounded by ramparts laid out as promenades, and its streets are remarkable for the numerous specimens which they preserve of mediæval architecture. The cathedral, which dates in its earlier portions from the 13th century, is regarded as one of the finest in France, and the Hôtel de Ville, originally the house of Jacques Cœur, the famous jeweller under Charles VII., is a splendid example of the florid style of the 15th century. The house of the Lallemant family, built about 1520, that of Cujas, the famous jurist, dating from the 16th century, and now used as barracks for the *gendarmerie*, and the gate of Saint Ours, are also worthy of notice. The archiepiscopal palace, the great prison, and the *grand seminaire*, now converted into cavalry barracks, are the most important of the other buildings. There are also in the town a museum, a large public library, and a number of colleges. A certain amount of trade is carried on in grain, hemp, wood, skins, wool, and cattle; and cloth, leather, and cutlery are manufactured. There are also several breweries, and the nurseries in the neighbourhood are famous. In 1861 the city became the seat of a military arsenal, which is now of considerable importance. The population, stated at 22,465 in 1851, amounted in 1872 to 27,377. Bourges occupies the site of the Gallic town of *Avaricum*, mentioned by Cæsar as one of the most important of all Gaul. In 52 B.C., during the war of Vercingetorix, it was completely destroyed by the Roman conqueror, but under Augustus it rose again into importance, and was made the capital of Aquitania Prima. In 252 A.D. it became the seat of a bishop, the first occupant of the see being Ursinus. Captured by the Goths in 475, it continued in their possession till about 507. During the English occupation of France in the 15th century it became the residence of Charles VII., who thus acquired the popular title of king of Bourges. In 1463 a university was founded in the city by Louis XI., which continued for centuries to be one of the most famous in France, especially in the department of jurisprudence. On seven different occasions Bourges was the seat of ecclesiastical councils,—the most important being the council of 1438, in which the Pragmatic Sanction of the Gallican Church was established, and that of 1528 in which the Lutheran doctrines were condemned.

BOURIGNON, ANTOINETTE, a singular enthusiast of the 17th century, who excited considerable commotion by her religious doctrines, but whose name is now almost forgotten. She was born at Lille in the beginning of 1616; and her appearance as an infant was so deformed that the question of preserving her alive was seriously discussed. She manifested, while still very young, an extraordinary spirit of religious fervour, fostered, apparently, by her loneliness and the neglect of her parents. As she grew up this spirit increased in intensity. So few, it seemed to her, lived according to their professed Christian principles that she desired to be carried into the Christian countries. The unhappiness that she observed at home, from the severity of her father to her mother, gave her an invincible repugnance to marriage,—so much so that when it was desired that she should marry at the age of twenty she fled from her father's house in disguise. Her disguise, however, was soon discovered, and having fallen into the hands of a soldier, she ran worse risks than if she had remained to face her destiny at home. Her autobiography dwells upon these and other similar events of her life, when her virtue underwent violent assault, which she was happily able to resist. She is said to have been "endowed with a wonderful chastity, which remained unassailable by all force or enticement, and which not only preserved her own person pure, but diffused around her an ardour of continence."

Having been delivered from the hands of the soldier into which she had fallen in her wanderings, she became known to the archbishop of Cambray, under whose sanction she established a small society of nuns. She soon, however, became restless in her new occupation, in which she does not seem to have been successful. The archbishop withdrew his countenance, and for a time she returned to her native country, where she is said to have "passed many years in privacy and in a great simplicity of life." On the death of her parents she became entitled to some fortune, which she at first declined, but afterwards took possession of. She seems then to have become the head of a hospital at Lille for some time (1653, *et seq.*), but scandal having broken out in connection with it, she left and fled to Ghent (1662).

Here, apparently, she entered upon the higher prophetic phase of her life. "God revealed great secrets to her," which she began to proclaim; and soon she gathered around her a few ardent disciples. Her prophetic views were specially expounded in one of her books published at this time at Amsterdam, entitled *The Light of the World*. Some of her disciples formed the design of settling in the island of Noordstrand in Holstein. At first she seems to have declined to join them, but afterwards set out for the purpose. She did not remain long, disturbances having arisen not only against her opinions, but in the ranks of her own followers. She was evidently impatient of sharing her influence with any one, and is said to have been of very difficult and self-willed temper. She returned to Holland, and died there in 1680.

It is difficult to give any estimate of A. Bourignon's character and opinions. So far as appears, she was a visionary of the ordinary type, only distinguished by the rare persistency and audacity of her pretensions. Amidst all her enthusiasm she seems to have known how to look after her own interests. She is said never to have given alms to the poor, not even to the hospital which she superintended. She was willing to assist with her hand, but not with her money. Her main idea about religion was that it was a mere internal ecstasy, independent of both church and Bible. She had innumerable visions, from which source she chiefly drew her religious inspiration and knowledge. Among others she saw in vision Antichrist and Adam before the Fall; and she describes the appearance of the former minutely, even to the colour of his hair. Her visions and views she gave to the world in numerous treatises and pamphlets.

Her followers in Holland seem to have dwindled rapidly away, if they ever had any of the life of a distinct sect; but, strangely, her influence revived in Scotland in the beginning of the 18th century, so much so as to be a source of alarm to the Presbyterian Church, and to call forth not only one but several Acts of the General Assembly in denunciations of her doctrines and earnest caution against their contagion. These Acts are found severally in 1701, 1709, and 1710; and even at this last date it is alleged that "the gross heresies and errors going under the name of Bourignianism are greatly prevailing in the bounds of the national church." This is the explanation, no doubt, of the fact that Bourignianism is amongst the heretical sects which the clergy of the Church of Scotland are taken bound to "disown" at their ordination in a series of questions appointed to be put in 1711. The very name, however, is now generally unknown in Scotland, notwithstanding this strange survival of it; and should any one turn to the Act of Assembly of 1701, which professes to enumerate the opinions of M. Antonia Bourignon, and describes them as "impious, pernicious, and damnable," he will hardly get more light as to the nature of these opinions than elsewhere. They present an unintelligible conglomeration without coherency or order,—such subjects as the denial of election, the permission of sin, and the bondage of the will being mixed up with the quality of Christ's human nature, the perfection of the present life, and "that generation takes place in heaven, and that there are no true Christians in the world." Mlle. Bourignon's works were published in French at Amsterdam in 1686, in 19 vols. 8vo. Her *Vie extérieure*, by herself, to be found in the first volume is the chief authority for the earlier part of her life. *La Vie continuée de Mlle. Bourignon*, which occupies the whole of the second volume (author's name not given), treats of her life at length, but in a semi-legendary manner. Three of her works at least have been translated into English.—*An Abridgment of the Light of the World*, London, 1786; *A Treatise of Solid Virtue*, 1699; *The Restoration of the Gospel Spirit*, 1707.

BOURNE, Vincent, one of the most able modern writers of Latin verse, was born at Westminster towards the close of the 17th century. In 1710 he became a scholar at Westminster school, and in 1714 entered Trinity College, Cambridge. He graduated in 1717, and obtained a fellowship three years later. Of his after life exceedingly little is known. It is certain that he passed the greater portion of it as usher in Westminster school. He died on 2d December 1747. During his lifetime he published several small collections of his Latin poems, and in 1772 there appeared a very handsome 4to volume containing all Bourne's pieces, but also some that did not belong to him. The Latin poems are remarkable not only for perfect mastery of all linguistic niceties, but for graceful expression and genuine poetic feeling. A number of them are translations of English poems, and it is not too much to say that the Latin versions almost invariably surpass the originals. Cowper, an old pupil of Bourne's, Beattie, and Lamb have combined in praise of his wonderful power of Latin versification.

BOURNEMOUTH, a watering-place in the south of England, situated on the Hampshire coast about five miles from Christchurch. Its sheltered situation and desirable winter climate began to attract notice about 1840; and now it possesses five or six hotels, several churches, a library and reading-room, assembly-rooms, baths, and the usual accompaniments of a frequented watering-place. In 1855 a sanatorium for consumptive patients was erected by subscription, and various establishments of a similar nature have since been founded. A pier 800 feet long was opened in 1861, and in 1870 railway communication was afforded by a branch of the South-Western from Ringwood. The climate is remarkable for the equability of its temperature. According to observations from 1862 to 1872 the average maximum by day in July is 71°·9, and the average minimum by night in January 35°·6. The rainfall is about 30 inches in the course of the year, and the subsoil carries off water with great readiness. The surrounding country is extremely beautiful; and the buildings of Bournemouth itself are picturesquely disposed on the slope of a richly wooded hill. Population in 1871, 5906.

BOURRIENNE, Louis Antoine Fauvelet de, the early friend and biographer of Napoleon, was born at Sens in 1769. His friendship with Napoleon began at the military academy of Brienne, where they were class-fellows, but they did not meet for some time after leaving school, as Bourrienne's humble birth precluded him from military service. In 1789, having embraced the career of diplomacy, he was sent as attaché to Vienna, and thence proceeded to Leipsic where he studied for some time. In 1792 he returned to Paris and renewed his close acquaintance with Bonaparte. Towards the close of the same year he was sent as Secretary of Legation to Stuttgart, but the fall of the monarchy a few months later threw him out of office. He was imprisoned for a short time by the Saxon Government as an adherent of the Revolution, and did not return to Paris till 1795. In the following year, after a slight coldness between the friends, Napoleon invited Bourrienne to become his private secretary. The offer was accepted, and for six years the two lived on the most intimate and friendly terms. It was during this period that he accompanied Napoleon to Egypt. In 1802 implication in the disgraceful failure of the army-contractors Coulon caused his dismissal. Three years later, however, he was sent as *chargé d'affaires* to Hamburg. There he was accused of peculation, and was in consequence recalled and compelled to pay one million francs into the public treasury. Bourrienne never forgave this; he became one of Napoleon's bitterest enemies, and after the first abdication

held office for a short time under Talleyrand. In 1815 he was specially excluded from Napoleon's amnesty and fled to Belgium. After the fall of the emperor he sat for some years in the Chamber of Representatives, but his official salary could not support his extravagance, and in 1828 he took refuge from his creditors in Belgium. There he occupied himself in drawing up the *Mémoires* of Napoleon, which were published in 1829 and 1830. The revolution of 1830 and the discomforts of his private life so preyed upon his mind that his reason became unhinged, and he had to be removed to an asylum near Caen, where he died in 1834. Bourrienne's *Mémoires*, 10 vols. 8vo, 1829–31, contain much interesting information regarding Napoleon, but while lively and entertaining, they are in many points to be received with caution. Some of the inaccuracies were pointed out by Boulay de la Meurthe in *Bourrienne et ses erreurs*, 2 vols. 1830.

BOURSAULT, Edmund, a French dramatist and satirist, was born at Muci-l'Eveque, Burgundy, in 1638. On his first arrival in Paris in 1651 his power of language was limited to Burgundian patois, but he soon gained such reputation as an author, that Louis XIV. directed him to draw up a book for the education of the Dauphin. In compliance with this order Boursault produced his *Veritable étude des souverains*, which pleased so greatly the king that he offered to appoint the author tutor to his son, an office which Boursault's ignorance of Latin compelled him to decline. He obtained a considerable pension as editor of a rhyming gazette, which was, however, suppressed for ridiculing a capuchin, and Boursault was only saved from the Bastille by the influence of Condé. Two of his dramas, *Esope à la Ville* and *Esope à la Cour* were highly popular, and Corneille declared his tragedy *Germanicus* to be worthy of Racine. His best comedy was *Mercure Galant*, or *Comedie sans Titre*, as it was afterwards, named. He accused Molière of impiety, and assailed *L'Ecole des Femmes* in *Le Portrait du Peintre*. Molière retaliated by contemptuously referring to him in *L'Impromptu du Versailles*. His *Satyre des Satyres* was directed against Boileau, whom, however, he afterwards generously offered to assist. In return for this kindness Boileau erased Boursault's name from his satires. Boursault died at Montluçon, where he held the office of collector of taxes, September 15, 1701.

and eloquence in the great German series of histories of the sciences from the Renaissance downwards. The first volume of the *Geschichte des neuern Poesie und Beredsamkeit* appeared in 1805, the twelfth and last in 1815. It is a work of great research, and has very substantial merits. It is, however, somewhat unequal, the portions on German and Spanish literature being superior to any of the rest. Part of the extended work has been translated into English as a *History of Spanish Literature*. Bouterwek died in 1828.

BOVALI, Bouali, or Boali, a town of Africa, capital of the kingdom of Loango, situated in 4° 30′ S. lat. and 12° 1′ E. long., on the right bank of a river of the same name not far from the coast. The vicinity is fertile but unhealthy. A large trade is carried on in pepper, dye-woods, ivory, and slaves. Population estimated at 15,000.

BOVES, a township of Italy, in the province of Cuneo in Piedmont, situated at the foot of the Alps, about 4 miles from the city of Cuneo. There are iron-mines and marble quarries in the neighbourhood. Population, 9549.

BOVINO (the ancient *Vebinum* or *Vibonium*), a fortified town of Italy, province of Capitanata, 18 miles S.S.W. of Foggia. It is the seat of a bishopric and of a court of primary jurisdiction, and has a cathedral and several churches and convents. Here the Imperialists defeated the Spaniards in 1734. Population, 7088.

BOW, the weapon of the archer. See Archery, vol. ii. p. 371, and Arms and Armour, p. 553.

BOWDICH, Thomas Edward, an English traveller, born at Bristol in 1790, was brought up by his father for commercial life, and in 1814 obtained an appointment on the western coast of Africa. Two years afterwards, on his return home, he was sent out by the African Company as their agent to the king of the Ashantees. In 1819 he published a quarto volume giving an account of that remarkable people. He then seems to have spent a considerable time at Paris in the study of the natural sciences. During his stay in Europe he edited several works on Africa, and published an excellent pamphlet on the British settlements on the western coast of Africa. He again visited Africa in 1822, with a firm resolution of devoting himself to the exploration of its interior; but he was attacked by fever on the Gambia, and died January 10, 1824. His widow, who had accompanied him, edited several productions of his pen after his death.

BOWDITCH, Nathaniel, a self-taught Amercian mathematician, born in 1773, of humble parents, at Salem in Massachusetts. He was bred to his father's business as a cooper, and afterwards apprenticed to a ship-chandler. His taste for mathematics early developed itself; and he acquired Latin that he might study Newton's *Principia*. In 1795 he sailed as supercargo, in which capacity he made four long voyages; and, being an excellent navigator, he afterwards commanded a vessel, instructing his crews in taking lunar and other observations. He edited three editions of Hamilton Moore's *Navigation*, and in 1802 published a valuable work, *New American Practical Navigator*, founded on the earlier treatise by Moore. In 1804 he became actuary to a Boston insurance company; and in the midst of his active and useful career published a translation of the *Mécanique céleste* of Laplace, with annotations,—a work which will better prove the great acquirements of this self-taught philosopher than any laboured panegyric. He died at Boston in 1838. A life of Bowditch was written by his son in 1839, and is prefixed to the last volume, published posthumously, of the translation of Laplace.

BOWLES, Caroline Anne. See Southey, Caroline.

BOWLES, William Lisle, poet and critic, was born at King's Sutton, of which his father was vicar, in 1762. At

the age of fourteen he was entered on the foundation at Winchester school, the head-master at the time being Dr Joseph Warton. In 1781 he left as captain of the school, and proceeded to Trinity College, Oxford, to a scholarship to which he had been elected. Two years later he gained the chancellor's prize for Latin verse, and soon after left the university, not taking his degree as master till 1792. In 1789 he published, in a small quarto volume, *Fourteen Sonnets*, which met with considerable favour at the time, were hailed with delight by Coleridge and his young contemporaries, and have since been recognized as the first notes of the modern revolt against the artificial school of poetry, the traditions of which had descended from Pope. The *Sonnets* even in form were a revival, a return to the older and purer poetic style, and by their grace of expression, melodious versification, tender tone of feeling, and vivid appreciation of the life and beauty of nature, stood out in strong contrast to the affected common-places which at that time formed the bulk of English poetry. A second edition of the little volume was called for in the same year in which it had appeared, and there have been many subsequent editions. A few short pieces were published in 1790 and 1792, which were also received with favour. After taking his degree at Oxford he entered the church, and was soon appointed to the vicarage of Chicklade in Wiltshire. In 1797 he received the vicarage of Dumbleton in Gloucestershire, and in 1804 was presented to the vicarage of Bremhill in Wiltshire. In the same year he was collated by Bishop Douglas to a prebendal stall in the cathedral of Salisbury. In 1818 he was made chaplain to the Prince Regent, and in 1828 he was elected residentiary canon of Salisbury. He died at Salisbury in April 1850, aged 88. Of the longer poems published by Bowles none attain a very high standard of excellence, though all are distinguished by purity of imagination, cultured and graceful diction, and great tenderness of feeling. The most extensive were *The Spirit of Discovery*, 1804, which was mercilessly ridiculed by Byron; *The Missionary of the Andes*, 1815; *The Grave of the Last Saxon*, 1822; and *St John in Patmos*, 1833. Bowles is perhaps more celebrated as a critic of poetry than as a poet. In 1807 he published an edition of Pope's works with notes and an essay on the poetical character of Pope. In this essay he laid down certain canons as to poetic imagery which, with slight modification, have been since recognized as true and valuable, but which were received at the time with strong opposition by all admirers of Pope and his style. The "Pope and Bowles" controversy brought into sharp contrast the opposing views of poetry, which may be roughly described as the natural and the artificial. Bowles maintained that images drawn from nature are poetically finer than those drawn from art; and that in the highest kinds of poetry the themes or passions handled should be of the general or elemental kind, and not the transient manners of any society. These positions were vigorously assailed by Byron, Campbell, Roscoe, and others of less note, while for a time Bowles was almost solitary. Hazlitt and the Blackwood critics, however, came to his assistance, and on the whole Bowles had reason to congratulate himself on having once for all established certain principles which might serve as the basis of a true method of poetical criticism, and of having inaugurated, both by precept and by example, a new era in English poetry. Among other prose works from his prolific pen was a *Life of Bishop Ken*, 2 vols., 1830-31.

BOWLS, one of the oldest and most popular of English pastimes, the origin of which can be traced back to the 12th century. William Fitzstephens, in his *Survey of London*, written during the last quarter of that century, states that in the summer holidays youths took exercise amongst other pastimes *in jactu lapidum*, "in throwing of stones." This might be taken as referring to throwing stones by slings or other artificial means, were it not that the next pastime mentioned is "slinging of missiles to be delivered beyond a certain mark (*amentatis missilibus ultra metam expediendis*)." Fitzstephens was both an accurate observer and a careful writer, and he clearly alludes to two distinct exercises. In early days stone spheres are known to have been used for bowling, and the like thing and name were in vogue for the next two centuries, in fact till 11 Henry IV. (1409). There is little doubt, therefore, that Fitzstephens here refers to bowls. It has been a matter of speculation whether bowling was first practised in the open air on turf or under cover in alleys, and Fitzstephens may help to decide the question. He states that the citizens went outside the city walls into the suburbs to witness these games, but the alleys were within the walls and in the midst of the population. Again, these alleys were always held up as scenes of vice and debauchery, and it is certain that had they existed at this date they would have been included in the resorts forbidden to the clergy by the constitutions of Walter de Cantilupe, bishop of Worcester, 24 Henry III. (1240). In the Close Roll, 39 Ed. III. (1366) mem. 23, *jactus lapidum*, "throwing of stones," is mentioned as one of the *ludos inhonestos et minus utiles aut valentes*, "games alike dishonourable, useless, and unprofitable." But then there was a reason for this depreciation. The king was concerned lest the practice of archery, so much more important to the military spirit of the kingdom, should suffer, and the same reason prompted the action of Parliament. By 12 Rich. II. cap. 6 (1388), servants, artificers, and labourers were forbidden—amongst other games to play at *gettre de peer*, or "casting of the stone," as the practice of archery was becoming lax. This statute was confirmed by 11 Henry IV. cap. 4. (1409-10), wherein "*gettre de peer*" is again forbidden. From 17 Ed. IV. cap. 3 (1477-8) it appears that bowling still remained in disrepute; for "half-bowl" is included among the "many new imagined plays" which were followed by all classes "to their own impoverishment, and by their ungracious procurement and encouraging do induceen other into such plays till they be utterly undone and impoverished of their goods." Even murders, robberies, and felonies were the consequence. Accordingly, it was enacted that any one playing at half-bowl after the following Eastar, or the occupier or governor of any "house, tenement, garden, or other place," where such games are permitted, should be punished by fines and imprisonment. Here it is probable that both the outdoor and indoor games are referred to, as "house" and "garden" are mentioned, and it may be concluded that by this time alleys had sprung into existence in towns. This then may be considered the first mention of the game as practised under cover, though it is equally clear that alleys had not entirely superseded greens.

punishment was to be inflicted, except binding offenders over by their own recognizances, and making them find sureties not to break the law again. Artificers, servants, and the like, might play during Christmas time in their masters' houses and presence, but no one could at any time "play at any bowle or bowles in open place out of his garden or orchard," whilst a licence might be granted to any one worth over £100 per annum to play privately in his own domain, but not to keep any common or open place of play. By 2 and 3 Mary, cap. 9 (1555), these licences were cancelled, evidently for religious and political reasons, as they were considered excuses for "unlawful assemblies, conventicles, seditions, and conspiracies." The evil still continued and remained irrepressible. Stephen Gosson, in his *School of Abuse* (1579), says—

"Common bowling alleys are privy moths that eat up the credit of many idle citizens; whose gains at home are not able to weigh down their losses abroad; whose shops are so far from maintaining their play, that their wives and children cry out for bread, and go to bed supperless often in the year."

Again, twenty years later, Stow, in his *Survey of London*, states—

"What should I speak of the ancient daily exercises in the long bow by citizens of this city, now almost clean left off and forsaken? I overpass it; for by the means of closing in the common grounds, our archers, for want of room to shoot abroad, creep into bowling alleys and ordinary dining houses nearer home, where they have room enough to hazard their money at unlawful games. And there I leave them to take their pleasure."

Stow also mentions in another place that the gardens of old Northumberland House, in Coleman Street, City,

"Were made into bowling alleys, and other parts into dining houses, common to all comers for their money, there to bowl and hazard; but now, of late, so many bowling alleys and other houses for unlawful gaming have been raised in other parts of the city and suburbs, that this, their ancient and only patron of misrule, is left and forsaken of her gamesters." Again, Goswell Street is described as "replenished with small tenements, cottages, alleys, gardens, banqueting houses, and bowling places."

The law, doubtless, was transgressed with impunity until the beginning of the 18th century, when power was given by 2 George II. cap. 28, § 9 (1728), and confirmed by 18 George II. cap. 34 (1745), to commit offenders to prison. From this date alleys were rigorously suppressed, whilst greens began to increase rapidly; and, during the 18th century, no country gentleman's mansion was considered complete without one. There is evidence that it was a royal game, since Stow states that bowling alleys were amongst the additions made by Henry VIII. to Whitehall, and the unfortunate Charles I. was an enthusiast of the open-air pastime. During his confinement at Holmby, Northamptonshire, he frequently went over to Lord Vaux's at Harrowden, and Earl Spencer's at Althorpe, both of which seats possessed unrivalled bowling greens. He is said to have been engaged at the game when seized by Cornet Joyce. After the suppression of alleys "long bowling," or "Dutch rubbers," was practised for a short time. It consisted of bowling at nine pins, placed on a square frame 30 yards distant, but does not appear ever to have found much favour in England. The first regular bowling club of which there exists any trace is the Willowbank Club founded in Glasgow at the commencement of the 19th century. The game is now chiefly practised in the northern counties of England and in Scotland. In the present era of violent athletic exercises its principal votaries are middle-aged and elderly persons, to whom it affords a pleasant and not too vehement exercise during summer evenings.

For the outdoor pastime the first requisite is a smooth and level plot of turf, well mown, watered, rolled, and kept in order,—hence the comparison, "as smooth as a bowling green." The earliest delineation extant of the game shows two players with a ball each, but no jack or mark to bowl at. It is presumed from this that the first cast his bowl to constitute a mark for the second to play at and knock from its position. Probably it was soon found expedient to introduce some definite mark, and in a 13th century MS., marked 20 Ed. IV., in the Royal Library, there is a picture of a game of bowls being played with a small cone erected at each end. Here the principle was evidently the same as at present, viz., to see who could cast his bowl nearest the mark. The modern green may be laid out on any suitable piece of smooth and level turf. The dimensions vary, according to the ground available, but from 90 to 150 feet in length, with a proportionate width, is found most suitable. The bowls are made of *lignum vitæ*; and, instead of being perfect spheres, are more or less oval with a bias. Formerly bias was accorded them by loading one side with lead, but now the more simple method of turning one-half of the oval smaller or leaner than the other half is universally adopted. The chief difficulty of the game consists in each player's mastering the bias of his own particular bowl. The "jack" or mark to be bowled at consists of a white ball of smaller size, which has superseded the old-fashioned cones. "Pegs" are a length of cord, with one end firmly attached to a bone or wooden peg, and the other passing through a hole in a similar peg. They are used for measuring which of two bowls is nearest the jack; and, if the distance be under a yard, the "standard"—consisting of a light straw or reed —may be called into requisition. A "rub" or "set" is when a jack or bowl, *in transitu*, comes in contact with any object on the green. The "footer" is the small piece of material—cocoa-nut matting is the best—whereon each player stands in delivering his ball. "Cast," or "point," is the term for each unit in scoring the game, which is "up" or won when the number of casts agreed on have been obtained by the winning side. A "dead bowl" is one knocked off the green, or against one lying in the ditch, or an illegally played bowl, and must at once be removed from the green. Should the boundary of the green consist of fencing, touching the fence constitutes a dead bowl. "Mark," or "set a mark," means the delivery of the jack at the commencement of a game. The jack must be bowled at least 63 feet from the footer and not over 3 feet from the edge of the green. The bowling generally takes place alternately from the two "ends" of the green. A "void end" is when neither side can score a cast. "Turning the jack" is when a player claims the game to be finished as the bowls then lie, and can only occur when one side has but a single bowl to deliver, all the opposite side's bowls having been cast. For the rules of the outdoor game as now played, reference may be made to Mitchell's *Manual of Bowl-playing*, Glasgow, 1865.

In France, according to Cotgrave, there formerly existed a game termed *carreau*, somewhat similar to bowls, the jack or mark being set up on a square stone at the end of an alley.

In the United States of America a game of bowls, termed "Ten Pins," is very popular. It is strictly an indoor game, played in alleys 60 feet by 4 feet. Ten wooden pins are set up at the further end of the alley, in the shape of an equilateral triangle with the apex (termed the "king pin)" towards the players. The object is to knock down the greatest number of pins with the fewest balls. These are made of *lignum vitæ*, unlimited in size or weight, but perfect spheres, instead of being biassed. A game consists of ten "rolls" of three balls each (if necessary), or thirty in all. The score is kept on a large vertical slate with ten divisions, corresponding to the ten rolls, for each player. The chief point is to try and hit the king pin at the apex of the triangle, as this affords the best chance of knocking down all the pins. Should a player succeed in doing so with the *first* ball of a roll he

gains a "double spare," his bowling is over for that roll, and he is entitled to add whatever number of pins he knocks down with the first *two* balls of the next roll to the ten already down. Should he gain another double spare with the first ball of the succeeding roll he has to wait for the first ball of a third roll before the total score for the first roll can be ascertained, and so on in succession. Accordingly, should a player obtain a double spare in each roll—or ten in all—his total reaches 300, the highest attainable. If a double spare be scored with the first ball of the tenth roll, the player is entitled to bowl his two remaining balls at once as he has no further rolls to play. Should he knock down all the pins with the first *two* balls of a roll, he gains a "single spare," his bowling is over for that roll, and he is in a similar manner entitled to add whatever number of pins he knocks down with the *first* ball of the next roll to the ten already down. The technical name for this method of scoring is "counting old and new." There are a few ten-pin alleys in London and the suburbs, but the pastime is not much practised in England. The rules will be found in *The Modern Pocket Hoyle*, New York. (H. F. W.)

BOWRING, SIR JOHN, an eminent English linguist, translator, political economist, and miscellaneous writer, was born at Exeter, October 17, 1792. He was a descendant of an old Puritan family; and he became in early life an ardent disciple in the school of utilitarianism and philosophical radicalism, whose prophet was Jeremy Bentham. He did not, however, share his master's contempt for poetry and the belles lettres, but was a diligent student of literature and foreign languages, especially those of Eastern Europe. His attainments as a linguist were of remarkable extent. He stated that he knew two hundred languages and could speak one hundred. This, of course, does not mean more than that he had some slight acquaintance with them; but it is certain that he had a pretty good knowledge of forty, and these were languages of various classes. This gives him a place, with Mezzofanti and Von Gabelentz, among the greatest linguists of the world. The first fruits of his study of foreign literature appeared in *Specimens of the Russian Poets*, published in two volumes in 1821–23. These were speedily followed by *Batavian Anthology* (1824), *Ancient Poetry and Romances of Spain* (1824), *Specimens of the Polish Poets*, and *Servian Popular Poetry*, both in 1827. During this period he began to contribute to the newly-founded *Westminster Review*, of which he was appointed editor in 1825. By his contributions to the *Review* he obtained considerable reputation as political economist and parliamentary reformer. He advocated in its pages the cause of free trade long before it was popularized by the eloquence of Richard Cobden and John Bright. He pleaded earnestly in behalf of parliamentary reform, Catholic emancipation, and popular education. In 1828 he visited Holland, and during his stay there the university of Groningen conferred on him the degree of doctor of laws. In the following year he was in Denmark, occupying himself with preparations for the publication of a collection of Scandinavian poetry. Bowring, who had been the trusted friend of Bentham during his life, was appointed his literary executor, and was charged with the task of preparing a collected edition of his works. This appeared in eleven volumes in the years 1838 and 1839. Meanwhile Bowring had entered Parliament in 1835 as member for Kilmarnock; and in the following year he was appointed head of a Government commission to be sent to France to inquire into the actual state of commerce between the two countries. He was engaged in similar investigations in Switzerland, Italy, Syria, and some of the German States. The results of these missions appeared in a series of reports laid before the House of Commons. After a retirement of four years he sat in Parliament from 1841 till 1849 as member for Bolton. During this busy period he found leisure for literature, and published in 1843 a translation of the *Manuscript of the Queen's Court*, a collection of old Bohemian lyrics, &c. In 1849 he was appointed British consul at Hong-Kong, and superintendent of trade in China, a post which he held for four years. After his return he distinguished himself as an advocate of the decimal system, and published a work entitled, *The Decimal System in Numbers, Coins, and Accounts* (1854). The introduction of the florin as a preparatory step was chiefly due to his efforts. Knighted in 1854, he was again sent the same year to Hong-kong as governor, invested with the supreme military and naval power. It was during his governorship that a dispute broke out with the Chinese; and the irritation caused by his "spirited" or high-handed policy led to the second war with China. In 1855 he visited Siam, and negotiated with the king a treaty of commerce. After the usual five years of service he retired and received a pension. His last employment by the English Government was as a commissioner to Italy in 1861, to report on our commercial relations with the new kingdom. Sir John Bowring subsequently accepted the appointment of minister plenipotentiary and envoy extraordinary from the Hawaiian Government to the courts of Europe, and in this capacity negotiated treaties with Belgium, Holland, Italy, Spain, and Switzerland. In addition to the works already named he published—*Poetry of the Magyars* (1830); *Cheskian Anthology* (1832); *The Kingdom and People of Siam* (1859); a translation of *Peter Schlemihl*; translations from the Hungarian poet, Alexander Petöfi (1866); and various pamphlets. He was elected F.R.S. and F.R.G.S., and received the decorations of several foreign orders of knighthood. Bowring was twice married; his second wife survived him, with several sons, who have attained distinction in various fields. He died at Claremont, near Exeter, November 23, 1872.

BOXWOOD, the wood obtained from the Euphorbiaceous genus *Buxus*, the principal species being the well-known tree or shrub, *B. sempervirens*, the common box, in general use for borders of garden walks, ornamental parterres, &c. The other source of the ordinary boxwood of commerce is *B. balearica*, which yields the variety known as Turkey boxwood. The common box is grown throughout Great Britain, in the southern part of the European continent generally, and it appears to extend through Persia into India, where it is found growing on the slopes of the Western Himalayas. Only a very small proportion of the wood suitable for industrial uses is now obtained in Great Britain. The box is a very slow growing plant, adding not more than 1½ or 2 inches to its diameter in twenty years, and on an average attaining only a height of 16 feet, with a mean diameter of 10½ inches. The leaves of this species are small, oval, leathery in texture, and of a deep glossy green colour. *B. balearica* is a tree of considerable size, attaining to a height of 80 feet, with leaves three

and it is a favourite wood for small carvings. The use of boxwood for turnery and musical instruments is mentioned by Pliny, Virgil, and Ovid. The quantity of the wood which passes out from Constantinople yearly is estimated at from 5000 to 7000 tons, with about 1500 tons more of inferior and small pieces. While the consumption is continually increasing the present sources of supply are rapidly becoming exhausted, the forests near the sea are denuded of their best trees, and access to the wood growing in the interior of the countries around the Black Sea is difficult owing to the want of means of internal communication. The consequent increase of the cost of boxwood has led to frequent attempts to discover other woods which might take its place for the purposes of the wood engraver; but none of the numerous substitutes proposed have hitherto been found to possess the necessary combination of properties.

BOYACA, a village in the state of Boyaca, in the Republic of Colombia, situated about 20 miles south of the capital Tunja, and celebrated as the scene of the victory of Bolivar over the Spaniards in 1819. See Bolivar.

BOYCE, Hector. See Boece, vol. iii. p. 849.

BOYCE, William, an English musical composer of eminence, was born in London in 1710, and died there in 1779. As a chorister in St Paul's he received his early musical education from King and Dr Greene, and he afterwards studied the theory of music under Dr Pepusch. In 1736 he was appointed organist of St Michael's church, Cornhill, and in the same year he became composer to the chapel royal. In 1749 he received the degree of doctor of music from the University of Cambridge, as an acknowledgment of the merit of his setting of the ode performed at the installation of the duke of Newcastle as chancellor. He became master of the king's band in succession to Greene in 1757, and soon afterwards he was appointed principal organist to the chapel royal. As an ecclesiastical composer Boyce ranks among the best representatives of the English school. His two church services and his anthems, of which the best specimens are *By the Waters of Babylon* and *O, Where shall Wisdom be found*, are still frequently performed. Of his other works the best known are the serenade of *Solomon*, a setting of David's lamentation over Jonathan, and twelve trios for two violins and a bass, which were long popular. One of his most valuable services to the art was his publication (1760) of a collection of English church music in three volumes quarto, which included all the best compositions of the two preceding centuries. The collection had been begun by Greene, but it was mainly the work of Boyce.

BOYD, Zachary, a learned clergyman of the Scottish Church, was born towards the end of the 16th century, and died in 1653 or 1654. He was for many years regent in the college of Saumur in France, but returned to his native country in 1621, to escape the persecution of the Protestants. In 1623 he was appointed minister of the Barony church in Glasgow, and held the office of rector of the university in the years 1634, 1635, and 1645. He bequeathed to the university the half of his fortune, a sum amounting to £20,000 Scots, besides his library and MSS. His bust over the gateway within the court commemorates his important benefactions. The number of his published works was considerable, and eighty-six of his MSS. are said to be preserved in the library of Glasgow College. His poetical compositions are not without some merit, though the remarkable eccentricity of some of them has generally made them a source of amusement rather than edification. The common statement that he made the printing of his metrical version of the Bible a condition of the reception of his grant to the university is a mistake.

His best known works are *The Last Battle of the Soule in Death*, 1629, of which a new edition, with a biography by Mr Neil, was published at Glasgow in 1831; *Zion's Flowers*, 1644; the *English Academie*; and *Songs of Zion*.

BOYDELL, John, an engraver, chiefly known by his plates illustrating Shakespeare, was born at Dorrington in 1719. At the age of twenty-one he came to London and was apprenticed for seven years to an engraver. In 1746 he published a volume of views in England and Wales, and started in business as a printseller. By his good taste and liberality he managed to secure the services of the best artists, and his engravings were executed with such skill that his business became extensive and lucrative. He succeeded in his plan of a Shakespeare gallery, and obtained the assistance of the most eminent painters of the day, whose contributions were exhibited publicly for many years. The engravings from these paintings form a splendid companion volume to his large edition of Shakespeare's works. Towards the close of his life Boydell sustained severe losses through the French Revolution, and was compelled to dispose of his Shakespeare gallery by lottery. It had been his wish and intention to bequeath it to the nation. He died in 1804 before the lottery took place. Some years before his death he had held the position of Lord Mayor of London.

BOYER, Abel, a well-known lexicographer and historian, was born at Castres in France in 1664. Upon the revocation of the Edict of Nantes he first went to Geneva, and then to Franeker, where he finished his studies. Finally he came to England, where he soon acquired such a proficiency in the English language, that he became an author of considerable note, and was employed in writing several periodical and political works. He had for many years the principal management of a newspaper called the *Postboy*, and he likewise published a monthly work entitled *The Political State of Great Britain*. He died at Chelsea in 1729.

He wrote—*Life of Queen Anne*, folio; *History of William III.*, 3 vols. 8vo; *Annals of the Reign of Queen Anne*, 11 vols. 8vo; his best known work is the *Dictionary and Grammar of the French Language*.

BOYER, Alexis, a distinguished French surgeon, was born on the 1st of March 1757, at Uzerches in Limousin. His father was in the humble station of a tailor, and the son received the elements of a medical education in the shop of a barber-surgeon in a provincial town. His evident talent induced his friends to procure his removal to Paris, where he had the good fortune to attract the notice of his two distinguished masters, Louis and Dessault; and his unwearied perseverance, his anatomical skill, and finally his dexterity as an operator, became so conspicuous, that at the age of thirty-seven he obtained the appointment of second surgeon to the Hôtel Dieu of Paris, and was elected professor of operative surgery in the École de Santé. This latter appointment he soon exchanged for the chair of clinical surgery,—a department in which his manual dexterity and his admirable lectures on surgical subjects gained him the highest reputation, and introduced him to extensive practice. Perhaps no French surgeon of his time thought or wrote with greater clearness and good sense than Boyer; and while his natural modesty made him distrustful of innovation, and somewhat tenacious of established modes of treatment, he was as judicious in his diagnosis, as cool and skilful in manipulating, as he was cautious in forming his judgment on individual cases. In 1805 Napoleon nominated him imperial family surgeon, and, after the brilliant campaigns of 1806–7, conferred on him the legion of honour, with the title of Baron of the Empire, and a salary of 25,000 francs. On the fall of Napoleon the merits of Boyer secured him the favour of the succeeding sovereigns of France, and he was consulting-surgeon to Louis XVIII., Charles X., and Louis Philippe.

In 1835 he succeeded Deschamps as surgeon-in-chief to the Hôpital de la Charité, and was chosen a member of the Royal Academy of Sciences of the Institute of France. From the period of his wife's death, which he took much to heart, his health declined, and he died November 23, 1833, at the age of seventy-six.

His two great works are—*Traité complet de l'anatomie*, in 4 vols. 8vo, 1797–99, of which a fourth edition appeared in 1815, and *Traité des maladies chirurgicales et des operations qui leur conviennent*, 11 vols. 8vo, 1814–26. Of this work a new edition (the 5th), with additions by M. Ph. Boyer, in 7 vols., was published in 1844–53.

BOYER, Jean Baptiste, an eminent French physician, born at Marseilles in 1693. He devoted a long life to the special investigation and treatment of contagious epidemics, with a courage and success which have rarely been surpassed. On the last appearance of the plague in western Europe in 1720, he was one of the physicians sent from Paris by the Government to succour the inhabitants of his native city, then visited by this great calamity. The fearless zeal and ability which he displayed on that occasion procured him a pension and the title of physician in ordinary to the king. Much of his subsequent life was spent in similar expeditions, devoted to philanthropy, wherever pestilential epidemics prevailed; and the value of the services of Boyer were fully acknowledged at Paris, Trèves, Beauvais, Montagne, Brest, and at several places in the Spanish peninsula. He died in 1768.

His best known writings are—*Account of the Plague at Marseilles in 1720*, and *Observations on the Epidemic that prevailed at Beauvais*, Paris, 1750.

BOYER, Jean Piérre, a mulatto general, and for some time the President of Hayti, was born at Port-au-Prince in 1776. He joined the negroes in their war of independence, but after the secession of Toussaint l'Ouverture with his party, was compelled to retire to France. He was well received by Napoleon, and obtained a commission in Leclerc's expedition. After the death of Dessalines, the king of Hayti, Boyer joined Pétion in proclaiming a republic and resisting Christophe, Dessalines's successor. He gallantly and successfully defended Port-au-Prince against the negro troops of Christophe, and on the death of Pétion was named president of the Haytian republic. Two years later the death of Christophe removed his only rival, and he gained almost undisputed possession of the whole island. Absolute power, however, produced its usual effects; Boyer became arbitrary, capricious, and cruel. In 1825 the French compelled the Haytian senate to acknowledge their supremacy, and to guarantee a payment of 150 millions of francs in return for certain liberties granted. The weight of this enormous debt excited the greatest discontent in Hayti. Boyer was able to carry on his government for some years longer, but in 1842 a violent insurrection overthrew his power, and compelled him to take refuge in Jamaica. He resided there till 1848, when he removed to Paris, where he died in 1850.

BOYLE, Charles, earl of Orrery in Ireland, and baron of Marston, in the county of Somerset, the second son of Roger second earl of Orrery, was born at Chelsea in 1676. He was educated at Christ Church, Oxford, and soon distinguished himself by his learning and abilities. Like the first earl of Orrery, he was an author, soldier, and statesman. He translated Plutarch's life of Lysander, and published an edition of the epistles of Phalaris, which engaged him in the famous controversy with Bentley. See Atterbury and Bentley. He was three times member for the town of Huntingdon; and on the death of his brother, Lionel, earl of Orrery, in 1703, he succeeded to that title. He entered the army, and in 1709 was raised to the rank of major-general, and sworn one of her Majesty's privy council. At the battle of the Wood he acted with di[illegible]ed bravery. He was appointed queen's envoy to the states of Brabant and Flanders; and having discharged this trust with ability, he was created an English peer, as Baron of Marston, in Somersetshire. He received several additional honours in the reign of George I, but having had the misfortune to fall under the suspicion of the Gover[illegible] he was committed to the Tower, where he remained six months, and was then admitted to bail. On a subsequent inquiry it was found impossible to criminate him, and he was discharged. He died, after a slight illness, on the 28th of August 1731. Among the works of Roger, earl of Orrery, will be found a comedy, entitled *As you find it*, written by Charles Boyle. The orrery, an astronomical instrument, invented, or at least constructed, by Graham, was named after the earl, who used to amuse his leisure hours with mechanical toys.

BOYLE, John, earl of Cork and Orrery, a nobleman distinguished for his literary attainments, was the only son of the subject of last notice, and was born January 2, 1707. He was educated at Christ Church College, Oxford, and was led by indifferent health and many untoward accidents to cultivate in retirement his talents for literature and poetry. His works are neither numerous nor remarkable. His translation of the *Letters of Pliny the Younger*, with various notes, for the use of his eldest son, was published in 1751, 2 vols. 4to. He also published a *Life of Swift*, in several letters addressed to his second son, and *Memoirs of Robert Carey, Earl of Monmouth*, from a manuscript presented to him by a relation. He died November 16, 1762. His letters from Italy did not appear until 1774, when they were edited, with his life prefixed, by the Rev. J. Duncombe.

BOYLE, Richard, one of the greatest statesmen of the 17th century, generally styled the Great Earl of Cork, was the youngest son of Roger Boyle, and was born at Canterbury, October 3, 1566. He studied at Benet College, Cambridge, and afterwards became a student in the Middle Temple. Having lost his parents, and being unable to support himself in the prosecution of his studies, he became clerk to Sir Richard Manwood, chief baron of the exchequer; but finding this employment little likely to improve his fortune, he went to Ireland. He was then about twenty-two years of age, graceful in person, and possessing many accomplishments, which enabled him to render himself useful to some of the principal persons employed in the Government. In 1595 he married one of the daughters and co-heiresses of William Apsley. This lady died four years afterwards, leaving him a landed estate of £500 a year. He purchased land extensively, and was looked upon with great jealousy by some of the neighbouring proprietors, who did all they could to blacken his character. But he was fortunate enough to find a patron in Queen Elizabeth, and his fortunes, which had been broken by the Munster rebellion, rapidly improved. In consequence of various services and the great ability he
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command of his four sons, he defended the province of Munster, and took several strong castles. During this time he paid his forces regularly; and when all his money was exhausted, he converted his plate into coin. He died on the 15th September 1644.

BOYLE, Richard, earl of Burlington and Cork, son of the subject of last notice, was born in 1612. He greatly distinguished himself by his loyalty to Charles I., whom during his troubles he supplied with both money and troops; but at last he was obliged to compound for his estate. He contributed all in his power to the Restoration, and by Charles II. was created earl of Burlington (Bridlington) in 1663. He died in January 1697–8, aged eighty-six.

BOYLE, Robert, one of the greatest natural philosophers of his age, and one of the founders of the Royal Society of London, was the seventh son and fourteenth child of Richard Boyle, earl of Cork, and was born at Lismore Castle in the province of Munster, Ireland, January 25, 1627. In his earliest years he learnt to speak Latin and French, and he was only eight years old when he was sent to Eton, his father's friend, Sir Henry Wotton, being then provost of the college. Here he studied about three years, and was next placed as private pupil with the rector of Stalbridge in Dorsetshire, where his father had just taken up his residence. In 1638 after a visit to London he travelled in France accompanied by a French tutor, and studied above a year at Geneva. In the autumn of 1641 he visited Switzerland and Italy, spending the winter of 1641–42 at Florence. Here he studied the works of Galileo, who died near Florence the same winter. On reaching England in 1644 he learnt the death of his father, who had left to him the manor of Stalbridge and estates in Ireland. It was in the following year that he became a member of a society of scientific men, who in consequence of the political agitation of the times used to hold their meetings with as much privacy as possible, first in London and afterwards at Oxford; this became subsequently famous as the Royal Society. In 1646 he settled at Stalbridge, and from that time his whole life was devoted to study, scientific research and experiments, and authorship. After making several visits to his estates in Ireland he took up his abode at Oxford in 1654, and there enjoyed the society of many learned men. He resided at Oxford for fourteen years; and it was during this period that he made important improvements in the air-pump, and by a long series of experiments with it made various discoveries on the properties of air, the propagation of sound, &c., which are recorded in his voluminous writings. Boyle was at the same time an ardent student of theology, and numbered among his friends the eminent Orientalists Pococke, Hyde, and Clarke, and Dr Thomas Barlow, Bodleian librarian and bishop of Lincoln. At the Restoration he was favourably received at court, and was advised to enter the church; but this he declined to do, alleging that it was not his vocation, and that he believed his writings on religious subjects would have greater weight coming from a layman than from a paid minister of the church. His anxiety to promote the spread of Christianity appeared in various munificent acts. He bore the expense of preparing a Malay translation of the Gospels and the Acts of the Apostles, and of an Irish version of the Bible. He contributed largely to the cost of the Welsh Bible and of a Turkish New Testament, and gave a large sum to the translator of the work of Grotius *De Veritate* into Arabic. He supported liberally the projects for spreading the Gospel in India and in America, and gave away annually a large sum for charitable purposes. He made his first appearance as author in 1660, by the publication at Oxford of a volume entitled *New Experiments, Physico-Mechanical, touching the Spring of Air and its Effects*, and of a devotional work entitled *Seraphic Love, or some Motives and Incentives to the Love of God.*

When the Royal Society was incorporated (1663) Boyle was named a member of the council. He communicated many important memoirs to the *Philosophical Transactions*, and, in 1680, was elected president of the society, but from a scruple about oaths he declined this honour. Boyle was at one time deeply interested in alchemy, and carried on experiments on the transmutation of metals, in which Newton also took much interest. It was through his efforts that the statute of Henry IV. cap. 4, against the multiplying of gold and silver was repealed in 1689. After leaving Oxford in 1668 he settled in London; and here he spent the rest of his days, residing in the house of his sister Lady Ranelagh. He was never married. In person he was tall, slender, and of a pale countenance. His constitution was far from robust, and throughout his life he suffered from feeble health and low spirits. While his scientific discoveries procured him wide and lasting renown, his private character and virtues, the charm of his social manners, his wit and conversation, endeared him to a large number of personal friends. As a man of science he was ranked by his contemporaries among the greatest; and although some abatement of this very high estimate has since been admitted, he still holds a place of distinction as the first great investigator who carried out in his labours the principles of the *Novum Organum*. So earnest was his devotion to Bacon that for many years he could not be persuaded to read the works of Descartes, lest he should be tempted out of his chosen path. His strength lay in the patient research and observation of facts. He did not display that power of divination of their meaning and, of detection of their relations which is the characteristic of genius. His desire was to contribute by his researches, in the true spirit of the Baconian philosophy, to the service of man's life; and in this he had a large measure of success. The same practical aim is apparent in his theological writings. He was no controversialist, and does not appear to have taken much, if any interest in the great political and religious movements of his day. About 1690 his health began seriously to fail, and he was obliged gradually to withdraw from his public engagements. He discontinued the communication of memoirs of new discoveries to the Royal Society, resigned the post which he had long held of governor of the corporation for propagating the Gospel in New England, and announced by public advertisement his intention no longer to receive visits. The "retired leisure" which he thus secured was devoted to important chemical investigations, the account of which he left "as a kind of hermetic legacy to the studious disciples of that art." His health became worse in 1691. On the 23d of December of this year his sister, Lady Ranelagh, with whom he had lived for more than twenty years, died; and a week later, December 30, Boyle died himself. His remains were interred in the churchyard of St Martin's in the Fields, and his funeral sermon was preached by his friend Dr Burnet, bishop of Salisbury, author of the *History of the Reformation*. By his will he founded and endowed the "Boyle Lectures," the purpose of which is the demonstration of the truth of the Christian religion against atheists, theists, pagans, Jews, and Mahometans.

It is unnecessary to do more than enumerate the more important publications of this laborious investigator. His first work has already been mentioned. It was followed, in 1662, by *The Sceptical Chemist*, subsequently reprinted with additions. His *Considerations touching the Usefulness of Experimental Natural Philosophy* appeared in 1663, and was followed by a second part in 1671. His *Experiments and Considerations upon colours, with Observations on a Diamond that Shines in the Dark*, also appeared in 1663—a treatise which broke ground on a theme afterwards more profoundly treated by Newton.

His next scientific work was entitled, *New Experiments and Observations upon Cold* (1665). This was followed by the *Origin of Forms and Qualities according to the Corpuscular Philosophy* (1666); a continuation of his first work on the air (1669); *Tracts about the Cosmical Qualities of things, the Temperature of the Subterraneous Regions, and the Bottom of the Sea* (1669), a volume which gave rise to much discussion, its statements being founded on experiment; *Origin and Virtues of Gems* (1672); *Essays on the Subtilty and Determinate Nature of Effluvia* (1673); tracts on the *Saltness of the Sea*, the *Moisture of the Air*, the *Natural and Preternatural State of Bodies, Cold, Hidden Qualities of the Air, Celestial Magnets, Hobbes's Problem of a Vacuum*, and the *Cause of Attraction and Suction* (1674); *Experiments and Notes about the Mechanical Origin or Production of Particular Qualities*, including a discourse on electricity (1676); the *Aerial Noctiluca, or some new Phenomena, and a Process of a Factitious Self-shining Substance* (1680); *New Experiments and Observations upon the Icy Noctiluca, to which is added a Chemical Paradox* (1682); a further continuation of his first work on the air (1682); *Memoirs for the History of Human Blood* (1684); *Short Memoirs for the Natural Experimental History of Mineral Waters* (1685); *Medicina Hydrostatica* (1690); and *Experimenta et Observationes Physicæ* (1691). Of his religious and theological writings we may mention, *An Essay on Scripture*, of which one portion was published in 1663, and the whole at a later date by his friend Sir Peter Pett; *Occasional Reflections upon several Subjects* (1665), a strange medley of trivialities and grave thoughts, amusing, yet not wholly unwise, which was assailed and ridiculed by Dean Swift in *A Pious Meditation upon a Broomstick, in the Style of the Honourable Mr Boyle*, and by Butler in *An Occasional Reflection on Dr Charlton's feeling a Dog's Pulse at Gresham College* (a neat reprint of the *Occasional Reflections* was published at Oxford in 1848); *The Excellency of Theology, compared with Philosophy*, written in the year of the Great Plague, but not published till 1673; *Considerations about the Reconcilableness of Reason and Religion, with a Discourse about the Possibility of the Resurrection* (1655); *A Discourse of Things above Reason, inquiring whether a Philosopher should admit any such* (1681); a tract on the *High Veneration Man's Intellect owes to God* (1685); *A Free Inquiry into the vulgarly received notion of Nature* (1686); and *The Christian Virtuoso* (1690). Several other works appeared after his death, and among these were—*The General History of the Air designed and begun*; an account of his making the phosphorus, September 30, 1680; and *Medicinal Experiments*. An incomplete edition of Boyle's works appeared at Geneva some years before his death. A useful classified abridgment was published by Dr Peter Shaw, editor of an abridgment of Bacon's Philosophical Works. The first complete edition was that of Dr Birch, which appeared, with a Life of the author, in 5 vols. folio, in 1744. Another complete edition was issued in 6 vols. 4to, in 1772. A portrait of Boyle, by Kerseboom, which is in the possession of the Royal Society, formed part of the National Portrait Exhibition at South Kensington in 1866. Boyle bequeathed his natural history collections to the Royal Society.

BOYLE, ROGER, earl of Orrery, fifth son of the Great Earl of Cork, was born in April 1621, and was made Baron Broghill when only five years old. He distinguished himself while a student at Dublin College, and afterwards made the tour of France and Italy. Soon after his return he married Margaret Howard, sister to the earl of Suffolk; and passing over to Ireland with his bride he found the country in a state of rebellion, and assisted his father in opposing the insurgents. Upon the execution of the king, he retired to his seat at Marston in Somersetshire; but his spirit could ill brook this state of inactivity, and he therefore resolved to cross the seas, and apply to Charles II. for a commission to raise forces to restore the monarchy and recover his own estate. Under the pretence of visiting Spa for his health, he proceeded as far as London, where he received a message from Cromwell, then general of the parliamentary forces and a member of the committee of state, intimating his intention to wait upon him. During the interview Cromwell told him that the committee were apprised of his design: and when Broghill assured him that the intelligence was false, Cromwell produced copies of several of his confidential letters, which reduced him to the necessity of asking Cromwell's pardon, and requesting his advice in such a conjuncture. Cromwell told him, that though he had hitherto been a stranger to his person, he was not so to his merit and character; that he had heard how gallantly he had behaved in the Irish wars; and he concluded by offering him a command as general officer, exempt from all oaths and engagements,—adding that he should not be obliged to draw his sword against any but the Irish rebels. Lord Broghill, greatly surprised at so unexpected an offer, requested some time for deliberation. But Cromwell brusquely told him that he must determine instantly, that he himself was about to return to the committee, who were still sitting, and that if he rejected their offer, they had determined to send him to the Tower. Broghill, finding that his liberty and life were in the utmost danger, pledged his honour that he would faithfully serve against the Irish rebels; and accordingly, by Cromwell's instructions, he passed over into Ireland, where by many important services he fully justified the opinion which had been formed of him. A troop of horse which he had raised was soon increased to a regiment of 1500 men, and these he led into the field against the rebels. He was speedily joined by Cromwell, who placed the highest confidence in his new ally, and found him of the greatest value to the interests of the commonwealth.

When Cromwell became Protector, Lord Broghill was made one of his privy council, and admitted to great intimacy and confidence. He continued for some time to assist Richard Cromwell with his counsels, till, seeing that the weak nature of that amiable man would infallibly bring on his fall, he deemed it imprudent still to cling to one whom he could not save, and accordingly retired to his command in Ireland, where affairs shortly after took a turn extremely favourable to the design of the king's restoration. Lord Broghill was not a little instrumental in bringing about that event; and, in consideration of his eminent services, Charles created him earl of Orrery, September 5, 1660. He was soon after made one of the lords justices of Ireland; and his conduct, whilst at the head of affairs in that kingdom, was such as to add greatly to the general esteem in which his character was previously held.

His active and toilsome course of life at length brought on disease and infirmity; but, notwithstanding, he went over to England in 1665, at the king's desire, and mediated with success in a serious misunderstanding which existed between Charles and the duke of York.

On his return Lord Orrery, by his prudent and skilful measures, rendered abortive the scheme of a descent upon Ireland by the Dutch and French, planned by the duke de Beaufort, admiral of France.

About this time a quarrel with his old friend the duke of Ormond, arising from mutual jealousies, became so serious that the disputants resorted to England to defend their respective interests. This quarrel, though of a private beginning, became at last of a public nature. Lord Orrery was impeached, but defended himself so well that the prosecution failed. He lost, however, his public employments; but, retaining the king's favour, he still came frequently to court, and was often consulted on affairs of i

its mouth. About a mile west of Drogheda, an obelisk, 150 feet in height, marks the spot where the forces of William III. gained the celebrated victory over those of James II., on 1st July 1690, known as the "battle of the Boyne."

BOYSE, or Bois, John, one of the translators of the English Bible, was born in Suffolk in 1560. He was educated by his father, the rector of West Stowe, and at an early age exhibited great intellectual powers, being able to read Hebrew when only five years old. He completed his studies at Cambridge, particularly devoted himself to Greek, and for ten years was lecturer on that language in St John's College. At the age of thirty-six he married, and became rector of Boxworth, in Cambridgeshire. He was selected as one of the translators of the Bible, and is said to have completed not only his own share, the Apocrypha, but that of another clergyman. He received a prebendal stall in Ely cathedral from Bishop Andrews in 1615, but had no other preferment. He died in 1643, leaving behind him an immense mass of MSS.

BOZRAH. There are, according to the more usual opinion, two places of this name mentioned in Scripture, one a city of Edom, and the other a city of Moab. About the identification of these cities there has been much discussion, some maintaining that the former occupied the site of the modern village of el-Buseirah, about 25 miles S.E. of the Dead Sea, and that the latter was the city afterward known to the Romans as Bostra and at present as Busrah; while others suppose that the various passages of the Scriptures all refer to one place, and others again that there are two places, but that neither of them is to be identified with Bostra. The first view seems to be freer from difficulties than the other two. Bozrah, or el-Buseirah, is now a small village with a strong fortress on the top of a hill. It is the centre of a pastoral district, and its inhabitants, who number between 100 and 200, are all shepherds. Bozrah, Buzrah, or Bostra, on the other hand, is a very extensive collection of ruins of various ages, situated about 80 miles S. of Damascus. The area within the walls is about a mile and a quarter in length, and nearly a mile in breadth, while extensive suburbs lie without, to the east, north, and west. The principal buildings that can still be distinguished are a temple, an aqueduct, a large theatre (enclosed by a castle of much more recent workmanship), several baths, a triumphal and other arches, three mosques, and what are known as the church and convent of the monk Boheira. In 105 A.D., the city was beautified and perhaps restored from ruin by Trajan, who made it the capital of the province of Arabia. In the reign of Alexander Severus it was made a colony, and in 245 a native of the place, Philippus, ascended the imperial throne. By the time of Constantine it seems to have been Christianized, and not long after it was the see of an extensive bishopric. It was one of the first cities of Syria that was subjected to the Mahometans, and it successfully resisted all the attempts of the Crusaders to wrest it from their hands. As late as the 14th century it was a populous city. (See Burckhardt's *Travels*, Robinson's *Biblical Researches*, Porter's *Damascus*, Freshfield's *Caucasus*.)

BOZZARIS, Marcos, a Greek patriot, was born in Suli towards the close of the 18th century. With the remnant of the Suliotes he crossed in 1803 to the Ionian islands, and in 1820, with some 800 of his countrymen, joined the sultan against Ali Pasha. They soon, however, came over to Ali's party, and fought gallantly against their old enemies the Turks. After the death of Ali the Suliotes carried on the war with great success, and in 1822 were joined by a body of regular troops under Prince Mavrocordato. At the battle of Petta the Greeks were betrayed and defeated with heavy loss. Bozzaris fell back to Missolonghi, which he successfully defended until the arrival of a Hydriote fleet compelled the besiegers to retire. In the summer of 1823 he learned that a large Turkish force had again been despatched against the town, and resolving to anticipate the attack, he set out secretly with 1200 men. On the 20th of August he came upon the encampment of the Turkish vanguard, and a night attack was crowned with success. The victory of the Suliotes was saddened by the loss of Bozzaris, who fell while leading on his men. The assault on the Turkish camp has been made the subject of a very fine poem by Fitz-Greene Halleck.

BRA, a town of Italy in the province of Cuneo and district of Alba, on the River Stura, 25 miles N.E. of Cuneo. It has three parish churches, a gymnasium, a hospital, manufactures of silk and linen goods, and a considerable trade in corn, cattle, wine, and silk. Population, 12,946.

BRABANT, an extensive district in the Netherlands, which formerly constituted a separate duchy, but is now divided between Belgium and Holland. The Belgian portion includes the provinces of Brabant and Antwerp, while the whole of the Dutch portion is still known by its ancient name. Godfrey the Bearded, count of Louvain, who lived in the beginning of the 12th century, was the first to assume the title of count of Brabant, which his great-grandson, Henry I. the Warrior (1190–1235) exchanged for that of duke. The duchy passed in regular succession to Henry II. the Magnanimous (1235–1248), and Henry III. the Debonnair (d. 1261); but on the death of the latter the natural heir was supplanted by his younger brother John I. the Victorious, who added the district of Limburg to his possessions by the battle of Woeringen in 1288, in which he killed his competitor Henry of Luxembourg with his own hand. The next duke, John II., is memorable for the privileges he bestowed on his subjects by the statute of the Common Weal and the charter of Cortemberg. His successor, John III. the Triumphant, had to contend against a rebellion of Brussels and Louvain, and an offensive alliance of his neighbours, but managed to make himself not only secure but formidable. His three sons having died before him without issue, he was succeeded by his daughter, who had married Wenceslas of Luxembourg. The count of Flanders laid claim to the duchy, and, after a considerable struggle, was only bought off by the surrender of Antwerp. In 1404 the whole of Brabant was handed over to the countess of Flanders, and in 1406 her son took the title of duke. On his death at the battle of Agincourt, in which he fought on the side of the French, he was succeeded by John IV., whose marriage and divorce created much excitement in his day. In 1430, on the decease of Philip, second son of John IV., the duke of Burgundy, Philip the Good, was also recognized as duke of Brabant; and in 1440 the country passed to the house of Austria by the marriage of Mary of Burgundy his granddaughter to Maximilian the emperor, who transmitted it to Charles V. and thus to the crown of Spain. In 1648 the northern portion of the duchy succeeded in freeing itself from the Spanish tyranny, while southern Brabant continued under the yoke till 1714. Brabant possessed a liberal constitution known as the *Joyeuse Entrée, Blyde Inkomst*, or Joyous Entrance, which, *inter alia*, prevented the duke from raising the clergy above the other states of the realm, from prosecuting his subjects except in the regular courts, and from appointing foreigners to political office. A consent of the three states—the clergy, the nobles, and the representatives of the chief cities—was necessary for the passing of a law; and the towns had the right of refusing assistance

in any military expedition with the object of which they had not been previously made acquainted. The states usually met every two years, and a permanent committee of the three orders held its session in Brussels. The Brabantine court, under the native dynasty, was famous for the encouragement which it afforded to learning and literature; and more than one of the dukes have left proof of personal culture in the shape of songs. (See Dinaux, *Trouvères Brabançons, Hainuyers*, &c., 1863.)

BRABANT, NORTH, the modern Dutch province, has an area of 231 square miles, and in 1870 the population was 4,832,612. The surface is flat and the soil alluvial. The principal rivers are the Maas, the Aa, and the Dommel. The capital is 's Hertogenbosch, a city of 24,395 inhabitants, and the other chief towns are Breda (14,721), Bergen-op-Zoom (8352), Helmond (5301), and Tilburg (5262).

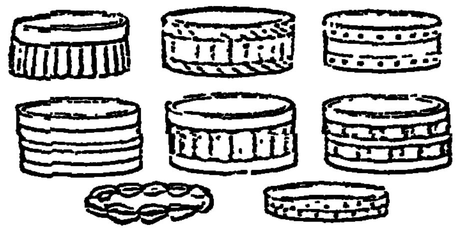
BRABANT, SOUTH, the modern Belgian province, has an area of 1262 square miles, and in 1870 the population was 879,814. Its general features are much the same as those of the Dutch province, though the surface is rather more varied in its elevation. The principal rivers are the Senne, the Dyle, and the Demer. The capital is Brussels with 177,954 inhabitants; and the other cities of importance are Louvain (32,976), Tirlemont (12,354), Nivelles (8800), Diest (7561), and Vilvorde (6844).

BRACCIOLINI, FRANCESCO, an Italian poet, born at Pistoia, of a noble family, in 1566. On his removing to Florence he was admitted into the academy there, and devoted himself to literature. At Rome he entered the service of Cardinal Maffeo Barberini, with whom he afterwards went to France. After the death of Clement VIII. he returned to his own country; and when his patron Barberini was elected pope, under the name of Urban VIII., Bracciolini repaired to Rome, and was made secretary to the Pope's brother, Cardinal Antonio. He had also the honour conferred on him of taking a surname from the arms of the Barberini family, which were bees; whence he was afterwards known by the name of *Bracciolini dell' Api*. During Urban's pontificate the poet lived at Rome in considerable reputation, though at the same time he was censured for his sordid avarice. On the death of the pontiff he returned to Pistoia, where he died in 1645. There is scarcely any species of poetry, epic, dramatic, pastoral, lyric, or burlesque, which Bracciolini did not attempt; but he is principally noted for his mock-heroic poem *Lo Scherno degli Dei*, published in 1618, similar but confessedly inferior to the contemporary work of Tassoni, *Secchia Rapita*. Of his serious heroic poems the most celebrated is *La Croce Racquistata*.

BRACCIOLINI, POGGIO. See POGGIO.

BRACELET, or ARMLET, a personal ornament, made of different materials, according to the fashion of the age and the rank of the wearer. The word is the French *bracelet*, which Ménage derives from *bracelletum*, a diminutive of *bracile*, all formed from the Latin *brachium*, the arm, on which it was usually worn. By the Romans it was called *armilla, brachiale, ocabus*; and in the Middle Ages *boga, bauga, armispatha*.

In the Bible there are three different words which the authorized version renders by "bracelet." These are—1. אצעדה *etsadah*, which occurs in Num. xxxi. 50, 2 Sam. i. 10, and which being used with reference to men only, may be taken to be the *armlet*; 2. צמיד *tsamid*, which is found in Gen. xxiv. 22, Num. xxxi. 50, Ezek. xvi. 11;—where these two words occur together (as in Num. xxxi. 50) the first is rendered by "chain," and the second by "bracelet:" 3. שרות *sheroth*, which occurs only in Isa. iii. 19. The first probably meant armlets worn by men: the second, bracelets worn by women and sometimes by men; and the third, a peculiar bracelet of chain-work worn only by women. In 2 Sam. i. 10, the first word denotes the royal ornament which the Amalekite took



Bracelets.

from the arm of the dead Saul, and brought with the other regalia to David. There is little question that this was such a distinguishing band of jewelled metal as we still find worn as a mark of royalty from the Tigris to the Ganges. The Egyptian kings are represented with armlets, which were also worn by the Egyptian women. These, however, are not jewelled, but of plain or enamelled metal, as was in all likelihood the case among the Hebrews. In modern times the most celebrated armlets are those which form part of the regalia of the Persian kings, and which formerly belonged to the Mongol emperors of India. These ornaments are of dazzling splendour, and the jewels in them are of such large size and immense value that the pair are reckoned to be worth a million of our money. The principal stone of the right armlet is famous in the East under the name of the *Deriâ-e-nur*, or "Sea of light." It weighs 186 carats, and is considered the diamond of finest lustre in the world. The principal jewel of the left armlet, although of somewhat inferior size (146 carats) and value, is renowned as the *Tâj-e-mah*, "Crown of the moon." The imperial armlets, generally set with jewels, may also be observed in most of the portraits of the Indian emperors.

Bracelets have at all times been much in use among barbaric nations, and the women frequently wear several on the same arm. The finer kinds are of mother of pearl, fine gold, or silver; others of less value are made of plated steel, horn, brass, copper, beads, &c.

This species of personal ornament was exceedingly common in Europe in prehistoric times. The bracelets of the Bronze Age were either of gold or bronze, silver being then unknown. In shape they were oval and penannular with expanding or trumpet-shaped ends, having an opening between them of about half an inch to enable them to be easily slipped over the wrist. Those of gold were generally plain, hammered rods, bent to the requisite shape, but those of bronze were often chased with elegant designs showing a cultivated taste. Some forms of spiral armlets of bronze, peculiar to Germany and Scandinavia, covered the whole fore-arm, and were doubtless intended as much for defence against a sword-stroke as for ornament. The

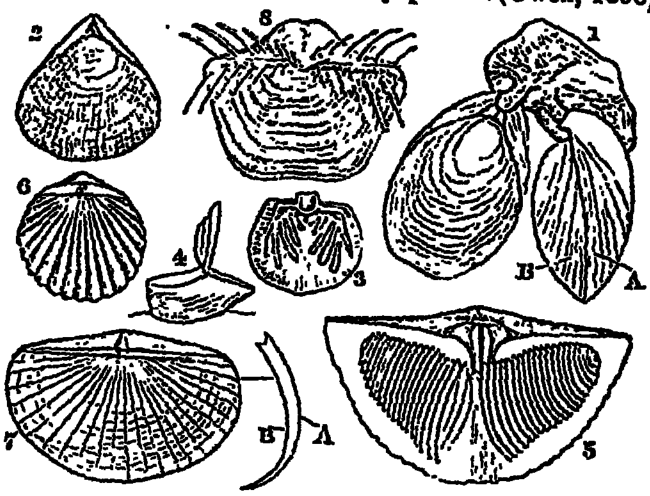
THE BRACHIOPODA constitute an important and well-defined class of Invertebrates, but the exact position the group should occupy in that division of the animal kingdom is still a matter upon which anatomists have not entirely agreed. For many years the species composing the class were referred to the genus *Anomia* of the Lamellibranchiata, but, as was judiciously observed by Edward Forbes, "a close examination shows that there is no relationship between them, but only a resemblance through formal analogy." Milne-Edwards separated the Mollusca into two great divisions, Mollusca and Molluscoida, and in the last he placed the Brachiopoda, Polyzoa, and Tunicata, an arrangement that has been followed by many naturalists. Although the greater number of zoologists have admitted the close connection existing between the Polyzoa and Brachiopoda, considerable doubt has been expressed with respect to the affinities and position of the latter in relation to the Tunicata; moreover, a strenuous effort has been made within the last few years by Steenstrup, Morse, Kowalevsky, A. Agassiz, and others, to demonstrate that the affinities of the Brachiopoda and Polyzoa are with the Worms, and that they should form classes of Annulosa, and be placed close to the Annelids.

According to Agassiz, the transition between such types as Pedicellina to Membranipora and other incrusting Polyzoa is readily explained from the embryology of *Thecidium*, and, in fact, all incrusting Polyzoa are only communities of Brachiopods, the valves of which are continuous and soldered together, the flat valve forming a united floor, while the convex valve does not cover the ventral one, but leaves an opening more or less ornamented for the extension of the lophore. Both Gratiolet and Hancock have expressed the opinion that the Tunicata are in no way related to the Brachiopoda, and that we cannot place these last and the Polyzoa along with the Tunicata in the same division. Gratiolet and some others have considered the Brachiopoda to be allied to the Crustacea, while even the asteridian affinities of the class have been hinted at by King.

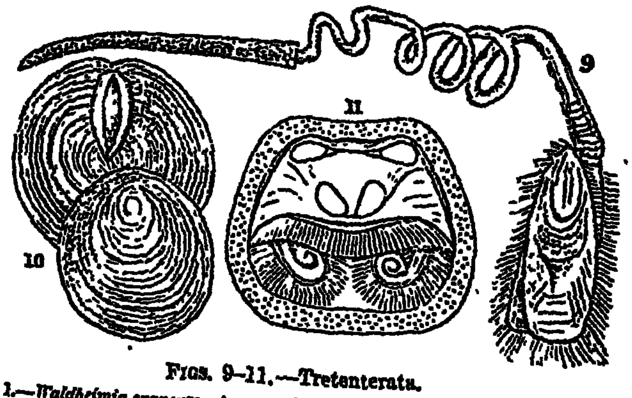
No doubt can be entertained, after perusing the admirable memoirs by Morse and Kowalevsky on the embryology of *Terebratula*, *Terebratulina*, *Argiope*, and *Thecidium*, that the genera composing the class and *Amphetrite* possess many important features in common, but almost any Invertebrate groups might be annelidilized by overrating certain points in their affinities. Mr Dall thinks that the general conclusion with reference to the affinities of the Brachiopoda will be something like this. There is much reason for supposing that all the Molluscs and Molluscoids came from the stock out of which the Worms have developed. Indeed, as Huxley has said, they are only isomerous Worms with many special modifications. It is natural, therefore, that the oldest and lowest forms should retain many of the characteristics of the oldest and most simple Worms, especially those which have been modified by a tubular habit. But, on the whole, the modifications are so important that we may continue to consider (if in the specializing tendency of present study we can retain any general divisions of Invertebrates) that the Molluscoids and Molluscs do form two groups somewhat aside from others, and somewhat more nearly related to each other than to the divisions external to them. Therefore, although it may turn out that the Brachiopoda constitute a class close to the Annelids, it cannot be denied that they possess many molluscan characters that cannot be overlooked, and are, under any circumstances, entitled by their importance and numerous distinctive features to constitute a well-defined and separate class.

The name BRACHIOPOD (βραχίων, an arm, πούς, ποδός, a foot) was proposed for the class by Cuvier in 1805, and by Dumeril in 1809, and has since been very extensively adopted. Blainville in 1824 proposed as a substitute for the Cuvierian name that of Palliobranchiata (*pallium*, a mantle; *branchiæ*, gills), on account of the respiratory system being combined with the mantle on which the vascular ramifications are distributed. Prof. King has always adopted the latter name, and perhaps rightly objects to Cuvier's on the ground that it is a misnomer, for the two variously curved and cirrated brachial or labial appendages, improperly designated as arms or feet, were subsequently found not to subserve the function of locomotive organs. Name.

Before describing the various parts of the animal and its shell, it may be as well to mention that it had been many times suggested by Owen, Bronn, Huxley, Gill, and others, that the class could be advantageously divided into two primary groups. Thus, for the first division, including *Lingula*, *Discina*, &c., the names Lyopomata (Owen, 1858), Two divisions.



FIGS. -8.—Clistenterata.



FIGS. 9–11.—Tretenterata.

FIG. 1.—*Waldheimia cranium*. A, ventral, B, dorsal valve
FIG. 2.—*Rhynchonella psittacea*.
FIGS. 3 and 4.—*Thecidium*.
FIG. 5.—*Spirifer*. Dorsal valve, showing calcareous spiral coils.
FIG. 6.—*Orthis calligramma*.
FIG. 7.—*Leptæna transversalis*. A, ventral, B, dorsal valve.
FIG. 8.—*Productus horridus*.
FIG. 9.—*Lingula pyramidata* (*after Morse*)
FIG. 10.—*Discina lamellosa*.
FIG. 11.—*Crania anomala*. Interior of dorsal valve, showing muscular impressions and labial appendages.

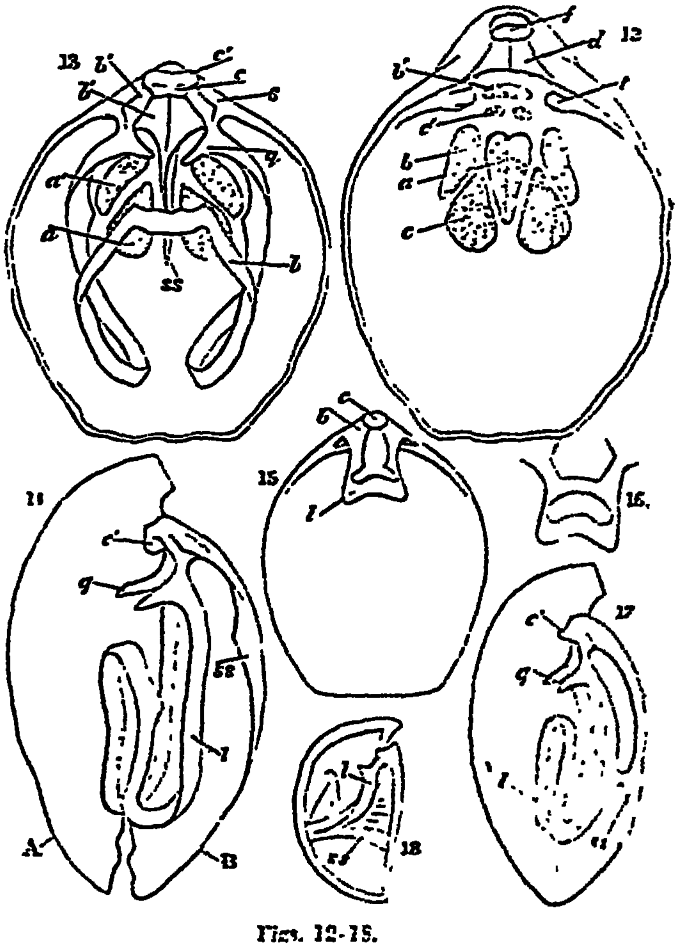
Pleuropygia (Bronn, 1862), Inarticulata (Huxley, 1869), Lyopomata (Gill, 1871), have been made use of; while for the second division, comprising *Terebratula*, *Rhynchonella*, &c., the names Athropomata (Owen, 1858), Apygia (Bronn, 1862), Articulata (Huxley, 1869), Arthro-

pomata (Gill, 1871) have been proposed. Prof. King, considering these names to be objectionable, and in some cases inadmissible on certain grounds, in 1873 substituted the name *Tretenterata* for the first group, the intestine being provided with an anal aperture, while the second group, to which he gives the name of *Clistenterata*, would embrace animals that are destitute of that organ; but it must also be remembered that the presence or absence of an anal aperture has been ascertained in only three or four recent genera, and that we are compelled, in a measure, to take for granted that what we find to be the case in *Lingula* and *Terebratula* is also so in the many extinct families and genera of which the animal cannot be examined.

With the character above enounced, we generally find structural modifications of the hinge and other differences in the animal, and especially so in what relates to the muscular system. In the opinion of Prof. King the absence of an anal vent in the Clistenterata makes them inferior to the aniferous Tretenterates.

The animal of the Brachiopod is in all cases protected by a shell composed of two distinct valves; these valves are always, except in cases of malformation, equal-sided, but not equivalved. The valves are, consequently, essentially symmetrical, which is not the case with the Lamellibranchiata or Conchifera,—so much so, that certain Brachiopod shells received the name *Lampades*, or lamp shells, by some early naturalists; but while such may bear a kind of resemblance to an antique Etruscan lamp, by far the larger number in no way resemble one. The shell is likewise most beautiful in its endless shapes and variations. In some species it is thin, semi-transparent, and glassy, in others massive. Generally the shell is from a quarter of an inch to about four inches in size, but in certain species it attains nearly a foot in breadth by something less in length, as is the case with *Productus giganteus*. The valves are also in some species very unequal in their respective thickness, as may be seen in *Productus Llangollensis*, *Davidsonia Verneuilii*, &c., and while the space allotted to the animal is very great in many species, as in *Terebratula sphæroidalis*, it is very small in others belonging to *Strophomena*, *Leptæna*, *Chonetes*, &c. The ventral valve is usually the thickest, and in some forms is six or seven times as great as the opposite one. The outer surface of many of the species presents likewise the most exquisite sculpture, heightened by brilliant shades, or spots of green, red, yellow, and bluish black. Traces of the original colour have also been preserved in some of the fossil forms; radiating bands of a reddish tint have been often seen in well-preserved examples of *Terebratula hastata*, *T. saculus*, *T. communis*, *T. biplicata*, and of several others. Some specimens of *T. carnea* are of a beautiful pale pink colour when first removed from their matrix, and E. Deslongchamps has described the tint of several Jurassic species.

The valves have been distinguished by various names, but those of *dorsal* and *ventral* are in most general use. The ventral valve is usually the largest, and in many genera, such as *Terebratula* and *Rhynchonella*, has a prominent beak, with a circular or otherwise shaped perforation or foramen at or near its extremity, partly completed by one or two plates, termed a deltidium. Through the foramen passes a bundle of muscular fibres, termed a peduncle, by which the animal is in many species attached to submarine objects during at least a portion of its existence. Other forms show no indication of ever having been attached, while some that had been moored by means of a peduncle during the early portion of their existence have become detached at a more advanced stage of life, the opening becoming gradually cicatrized, as is so often seen in *Strophomena* [illegible], *Orthisina* [illegible], &c. Lastly, some species have adhered to submarine objects by a larger or smaller portion of their ventral valve, as is the case with many forms of *Crania*, *Thecidium*, *Davidsonia*, &c. Some *Cranias* are always attached by the whole surface of their lower or ventral valve, which models itself and fills up all the projections or depressions existing either on the rock, shell, or coral to which it adhered. These irregularities are likewise, at times, reproduced on the upper or dorsal valve. Some species of *Strophalosia* and *Productus* seem also to have been moored during life to the sandy or muddy bottoms on which they lived, by the means of tubular spines of greater or lesser length. The interior of the shell varies very much according to families and genera. On the inner surface of both valves several well-defined muscular vascular and ovarian impressions are observable; they form either indentations of greater or lesser size and depth, or occur as variously shaped projections. In the *Trimerellidæ*, for example, some of the muscles are attached to a massive or vaulted



Figs. 12-18.

Fig. 12.—*Waldheimia flavescens.* Interior of ventral valve. *f*, foramen; *d*, deltidium; *t*, teeth; *a*, adductor impressions [illegible]

Fig. 13.—*Waldheimia flavescens.* Interior of dorsal valve. [illegible]

Fig. 14.—*Waldheimia flavescens.* [illegible]

of both recent and extinct genera. The apophysis is more or less developed in some genera than in others. In certain forms, as in *Terebratula* and *Terebratulina*, it is short and simple, and attached to a small divided hinge-plate, the two riband-shaped lamina being bent upwards in the middle (fig. 15). The cardinal process is prominent, and on each side of the hinge-plate are situated the dental sockets; the loop in *Terebratulina* becomes annular in the adult by the union of the oral processes or crura (fig. 16). In *Waldheimia* it is elongated and reflected; the hinge-plate large, with four depressions, under which originates a mesial septum, which extends more or less into the interior of the shell (figs. 13 and 14). In *Terebratella* the loop is attached to the hinge-plate and to the septum (fig. 17). In *Megerlia* it is three times attached, first to the hinge-plate, and then to the septum by processes from the diverging and reflected positions of the loop. In *Magas* the apophysary system is composed of an elevated longitudinal septum reaching from one valve to the other, to which are affixed two pairs of calcareous lamellæ, the lower ones riband-shaped; attached first to the hinge-plate, they afterwards proceed by a gentle curve near to the anterior portion of the septum, to the sides of which they are affixed; the second pair originate on both sides of the upper edge of the septum, extending in the form of two triangular anchor-shaped lamellæ (fig. 18). In *Bouchardia* the septum only is furnished with two short anchor-shaped lamellæ. Many more modifications are observable in different groups of which the great family *Terebratulidæ* is composed, and which will be found fully described in Davidson's and other authors' works on the Brachiopoda. In *Thecidium* (figs. 3, 4) the interior of the dorsal valve is variously furrowed to receive a testaceous ridge folded in two or more lobes. In the family *Spiriferidæ* there are two conical spires directed outwards, and nearly filling the cavity of the shell (fig. 5); while in *Atrypa* the broad spirally coiled lamellæ are vertical, and directed towards the centre of the valve. In the *Rhynchonellidæ* there are two short slender curved laminæ, while in many genera and even families, such as the *Productidæ*, *Strophomenidæ*, *Lingulidæ*, *Discinidæ*, &c., there exists no calcified support for the labial appendages. The ventral valve in many of the genera is provided with two curved hinge-teeth, which fit into corresponding sockets in the opposite valve, so that the valves cannot be separated without breaking one of the teeth. Nearly all the genera composing the division Clistenterata have their valves articulated, while those forming the Tretenterata have theirs kept in position by the means of muscles especially adapted to that purpose; but in one of the most natural groups, viz., that of the *Productidæ*, we find genera presenting both conditions.

Shell structure. The intimate structure of the shell has been minutely investigated by Dr Carpenter, Prof. King, Dr Gratiolet, and several others, and been found to be distinct from that of the Lamellibranchiata and Gasteropoda. Dr Carpenter informs us that there is not in the shell of the Brachiopoda that distinction between *outer* and *inner* layers, either in structure or mode of growth, which prevails among the ordinary bivalves; that it seems obvious, both from the nature of the shell substance and from the mode in which it is extended, that the whole thickness of the Brachiopod shell corresponds with the outer layer only of the Lamellibranchiata; and that he has occasionally met with a second layer in recent *Terebratulæ*, within the earlier portion of the shell, but confined to only a part of the surface instead of extending beyond it. In some families composing the Clistenterata it consists, according to Prof. King, of three divisions, the innermost and middle ones, which constitute the entire thickness of the valve, being calcareous with a prismatic or fibrous structure, while the oute divisions would consist of a very thin membrane. The innermost and intermediate divisions are in some families traversed by minute tubular canals, which pass from one surface to the other, for the most part in a vertical direction, and at tolerably regular intervals, but just before terminating near the outer surface of the epidermis their orifices suddenly become dilated, the lower half of the canals being often considerably smaller in diameter than the upper half. The canals are occupied by cæcal processes proceeding from the mantle or the fleshy covering of the animal. Their function is, according to Dr Carpenter, branchial or subservient to respiration; but if there exists an outer epidermis, as described by King, which covers their expanded terminations, there would be no communication between the surrounding sea water and the mantle. In the *Rhynchonellidæ* and in some other families the shell structure would, according to Dr Carpenter, consist of flattened prisms of considerable length, arranged parallel to each other with great regularity, and obliquely to the surface of the shell, the interior of which is imbricated by their outcrop. In certain genera, such as *Lingula* and *Discina*, no canals traverse the shell from the inner to the outer surface. The shell structure, according to Dr Gratiolet, would consist of two distinct elements, that is to say, a corneous or horny animal substance, and a testaceous one; these occur in alternate layers of unequal thickness. The testaceous layers recall the structure observable in the *Terebratulidæ*, being traversed by numerous canals of extreme or microscopic minuteness. As Mr Woodward observes in his excellent manual of the Mollusca, Prof. Huxley has suggested that the cæca are analogous to the vascular processes by which in many Ascidians the *tunic* adheres to the *test*, the extent of which adhesion varies in closely allied genera. It seems, however, strange that these tubular perforations should not have been essential to the species of every family composing the class if they are really subservient to respiration. The subject will therefore demand further consideration.

The anatomy of the Brachiopoda has been the subject of elaborate investigations by Cuvier, Vogt, Huxley, Hancock, Gratiolet, Woodward, Deslongchamps, King, and others, while of late years much light has been likewise thrown on the embryology and early stages of the groups by Steenstrup, Lacaze-Duthiers, Morse, F. Müller, Oscar Schmidt, M'Crady, Kowalevsky, and others. Some differences in opinion, it is true, have been and still are entertained with respect to the exact function to be attributed to certain parts of the animal, but on all essential questions there is a pretty general agreement. Soft parts of the animal.

According to Morse the Brachiopoda are reproduced by eggs, generally kidney-shaped and irregular, which are discharged from the anterior margin of the shell, and drop just beyond the pallial membrane, hanging in clusters from the setæ. Some uncertainty has prevailed as to whether there is a male and female individual. Lacaze-Duthiers and Morse state that the sexes are separate, and describe them as such in *Thecidium* and *Terebratulina*, and the French zoologist goes so far as to suggest that a difference is even observable in the shell, but the statement requires verification. Prof. Morse describes the embryo of *Terebratulina* with great minuteness during its six stages of development. It is divided into two, three, or four lobes clothed with vibratile cilia, and before becoming attached swims or whirls head foremost by means of vibratile cilia which cover the body. The same distinguished American zoologist describes with equal care the formation of the shell from its first stage of development to the adult condition. Lacaze-Duthiers alludes to two and four eye spots in the embryo of *Thecidium*, and states that the animal appears to be in some measure sensible to light.

The mouth conducts by a narrow œsophagus to a simple stomach which is surrounded by a large granulated liver. Owen's "hearts" have been found to be oviducts, while the true heart consists of a pyriform vesicle appended to the dorsal surface of the stomach. The digestive organs and viscera, as well as the muscles, which take up only a small place in the neighbourhood of the beak, are separated from the great anterior cavity, and protected by a strong membrane in the centre of which the mouth is situated. The nervous system consists of a principal ganglion of no great size.

Both valves are lined by a delicate membrane termed the pallium or mantle; it secretes the shell, and is generally fringed with horny bristles or setæ. It is composed of an outer and inner layer, between which are situated the blood channels or lacunes; in fact, all the internal parts of the shell are lined by the inner layer of the mantle, with the exception of the spots where the muscles attach themselves to the shell. The outer layer lines closely the inner surface of the valves to which it adheres, and in those species in which the shell is traversed by canals there exist, on the surface of the mantle facing the inner surface of the valves, corresponding short cylindrical membranous projections or lacunes, which insert themselves into the small tubular orifices that traverse the shell. The cæcal prolongations do not exist in those genera, such as *Rhynchonella*, where the shell is deprived of tubular perforations. The inner layer is rather thicker than the opposite one, and is covered with vibratile cilia. As stated by Nicholson and other anatomists, the blood channels form a remarkable system of more or less branched tubes, anastomosing with one another, and ending in the cæcal extremities. This, which has been termed by Huxley the arterial system, communicates with the perivisceral cavity by means of two or four organs, which are called pseudo-hearts, and which were at one time supposed to be true hearts. Each pseudo-heart is divided into a narrow, elongated external portion (the so-called "ventricle"), which communicates, as Hancock has proved, by a small apicial aperture with the pallial cavity; and a broad, funnel-shaped so-called "auricle," communicating on the one hand by a constricted neck with the so-called "ventricle," and on the other by a wide patent mouth with a chamber which occupies most of the cavity of the body proper, and sends more or less branched diverticula into the pallial lobes (Huxley). The channels vary in their dispositions and details in different genera, and as they project to some small extent, leave corresponding indentations on the inner surface of the shell, so that their shape and directions can very often be traced on fossil and extinct genera as well as if the animal was still in life; this may be seen in the numerous illustrations appended to Davidson's and other authors' works treating of fossil Brachiopoda. There are usually four principal arterial trunks in each lobe of the mantle; the two central ones run direct to the front, near to which they bifurcate, while the outer ones give off at intervals on the side facing the lateral margin of the valves a series of branches which bifurcate several times. It has been observed by Hancock that the inner lamina of the mantle, and more particularly that portion of it forming the floor of the great pallial sinuses, will undoubtedly assist in purifying the blood. In 1854, in his review of Davidson's great work on British fossil Brachiopoda, Oscar Schmidt called attention to an important anatomical omission, namely, the existence of a vast number of microscopic, flattened, calcareous, denticulated plates or spiculæ on certain parts of the surface of the mantle, and destined, no doubt, to stiffen and protect the portions that contain them; and it was, moreover, observed by Hancock, and afterwards by Deslongchamps, that these calcareous plates are not to be found equally distributed over all the surface of the mantle, but only in those portions in connection with the great lacunes or veins, the labial appendages, and the perivisceral cavity. These spiculæ do not appear to be present in every species, and are totally absent in *Lingula*, *Rhynchonella*, and others. Deslongchamps observes that if we examine the genera *Kraussina*, *Terebratula*, *Terebratulina*, *Megerlia*, and *Platydia*, we have a series wherein the number and consistence of the calcareous portions increase in a very rapid manner, and that the spicules lie over each other several times, leading the observers by insensible degrees to *Thecidium*, in which the spiculæ are soldered together, and incrust the mantle to such an extent that it is no longer distinct from the shell itself.

Brachial or labial appendages

The brachial appendages are a pair of singular organs eminently characteristic of the Brachiopoda; they often are more correctly termed *labial* appendages on account of each member being a prolongation of the lateral portion of the lips or margin of the mouth. The Lamellibranchs or Conchifera have analogous appendages, but very much less developed. They assume different shapes in different genera, and are supported, or otherwise, by the more or less complicated skeleton already described. The labial appendages, whatever may be the shape and convolutions they may assume, fill the larger portion of the cavity of the shell in front of the visceral chamber; they are formed of a membranous tube, fringed on one side with long flexible cirri, and occupy almost the whole of the pallial cavity, but were not capable of being protruded in those families in which they were folded back upon themselves and supported by a calcareous skeleton, as in *Waldheimia*, *Terebratella*, *Megerlia*, &c. Barrett, who has examined the a in life, states that *heimia* cranium, wh appendages being a small loop. Barr its cirri further, th brachial appendages

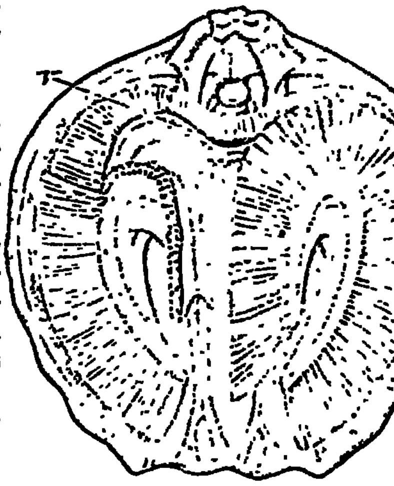
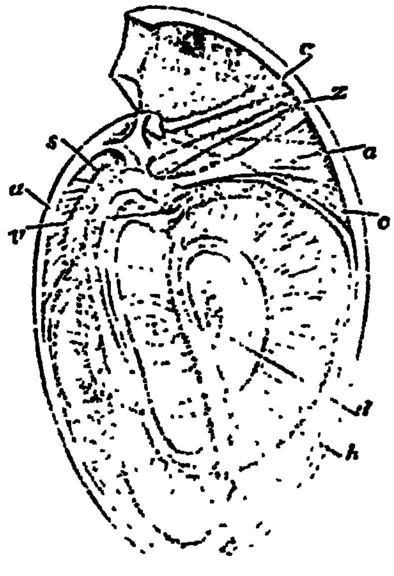


Fig. 19.

Waldheimia flavescens. Interior of dorsal valve, to show the position of the labial appendages. (A portion of the fringe of cirri has been removed to show the brachial membrane and a portion of the spiral extremities of the arms.)



almost constantly in motion, and often seen to convey small particles to the channel at their base, and that the cirri are bent up when the brachial appendages are retracted, but are generally uncoiled and straightened when the shell is opened, before which the animal has often been observed to protrude a few of its cirri, and move them about to ascertain if any danger threatened. In *Rhynchonella*, where the elongated spiral labial appendages are slightly supported only at their origin by two short calcareous processes, they can at the will of the animal, according to Owen and Morse, be unrolled and protruded to some distance beyond the margins of the valves, and when forcibly stretched out they are said to be more than four times the length of the shell, and to support some 3000 cirri. We may mention, likewise, that Otto Frederick Müller, having dredged from the Lake of Droeback, in Norway, a number of *Terebratulæ* (probably belonging to *Rhynchonella psittacea*), and placed them in a glass of water, he observed that they gracefully extended their spirally coiled brachial appendages. It must, however, remain for ever uncertain whether, in the extinct genera *Spirifera*, *Atrypa*, and others, in which the spirally coiled fleshy labial appendages were supported throughout their entire length by a calcified skeleton, the animal could protrude them beyond the margin of the valves. In some families—*Rhynchonellidæ*, *Productidæ*, and others—these organs are spiral and separate; in many the separation is only at their extremities. There can be very little doubt that these elegant organs, provided as they are with cirri and cilia, are not only instrumental in conveying microscopic organisms to the mouth, which, as seen in fig. 19, is situated between the appendages at their origin, but are likewise subservient to the functions of respiration. Hancock observes that to prove that the brachial organs subserve the function of gills, as well as that of sustentation, it is only necessary to refer to the manner in which the blood circles round the labial appendages and is carried to the cirri, but more particularly to its circulating through these latter organs, and returning direct from them to the heart.

Fig. 21.

Rhynchonella psittacea. Interior of dorsal valve. *s*, sockets; *b*, dental plates; V, mouth; *dc*, labial appendage in its natural position; *d*, appendage extended or unrolled.

As the number and position of the muscles differ materially in the two great divisions into which the Brachiopoda have been grouped, and to some extent also in the different genera of which each division is composed, it may be desirable to treat this subject under two separate heads. Unfortunately almost every anatomist who has written on the muscles of the Brachiopoda has proposed different names for each muscle, and the confusion thence arising is much to be regretted. In the Clistenterata, of which the genus *Terebratula* may be taken as an example, five or six pairs of muscles are stated by Hancock, Gratiolet, and others, to be connected with the opening and closing of the valves, or with their attachment to or movements upon the peduncle. First of all, the adductors or occlusors consist of two muscles, which, bifurcating near the centre of the shell cavity, produce a large quadruple impression on the internal surface of the small valve (fig. 13, *a*, *a'*), and a single divided one towards the centre of the large or ventral valve (fig. 12, *a*). The function of this pair of muscles is the closing of the valves. Gratiolet, who has likewise described with great minuteness the muscles of the Brachiopoda, informs us that those which close and open the valves were the only ones known to Pallas, but that he defined their position and functions clearly. The same was done by Blainville and Quenstedt, but the absence of good figures caused much uncertainty to prevail. This

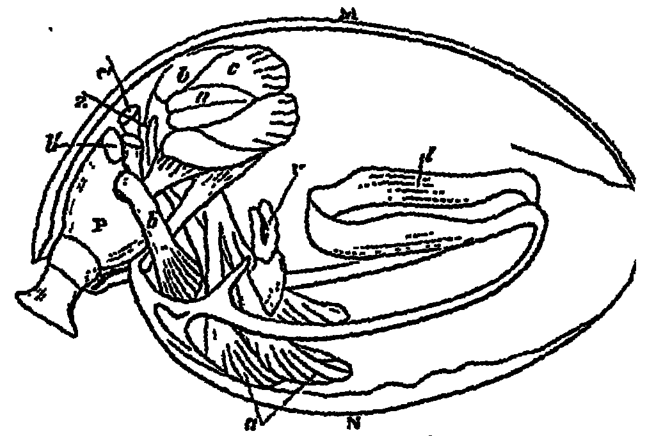


Fig. 22.

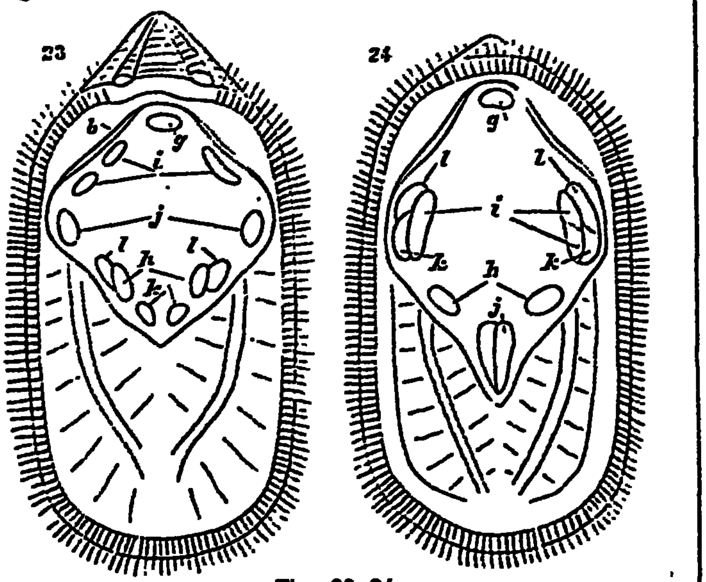
Waldheimia flavescens. Diagram showing the muscular system (*after Hancock*) M, ventral, N, dorsal valve; *l*, loop; V, mouth; Z, extremity of intestine; *a*, adductor; *c*, divaricators; *c'*, accessory divaricators; *b*, ventral adjustors; *b* peduncular muscles; *b''*, dorsal adjustors; P, peduncle.

deficiency was subsequently supplied by Hancock and Gratiolet's admirable illustrations. Two other pairs have been termed *divaricators* by Hancock, or *cardinal muscles* ("muscles diducteurs" of Gratiolet), and have for function the opening of the valves. The divaricators proper are stated by Hancock to arise from the ventral valve, one on each side, a little in advance of and close to the adductors, and after rapidly diminishing in size become attached to the cardinal process, a space or prominence between the sockets in the dorsal valve. The *accessory divaricators* are, according to the same authority, a pair of small muscles which have their ends attached to the ventral valve, one on each side of the median line, a little behind the united basis of the adductors, and again to the extreme point of the cardinal process. Two pairs of muscles, apparently connected with the peduncle and its limited movements, have been minutely described by Hancock as having one of their extremities attached to this organ. The *dorsal adjustors* are fixed to the ventral surface of the peduncle, and are again inserted into the hinge-plate in the smaller valve. The *ventral adjustors* are considered to pass from the inner extremity of the peduncle, and to become attached by one pair of their extremities to the ventral valve, one on each side of and a little behind the expanded base of the divaricators. The function of these muscles, according to the same authority, is not only that of erecting the shell, they serve also to attach the peduncle to the shell, and thus effect the steadying of it upon the peduncle. Gratiolet describes the peduncle with great care, and states it to be composed of two portions—1st, of a horny sheath formed of concentric epidermic layers, very analogous to that which Vogt has described in *Lingula*; and 2d, a fibrous stem enveloped by the sheath. This stem, composed of tendinous fibres, is fixed by its free extremity to different submarine objects; the other extremity passes through the foramen, and is ended by a bulbous projection.

Such is the general arrangement of the shell muscles in the division composing the articulated Brachiopoda, making allowance for certain unimportant modifications observable in the animals composing the different families and genera thereof. Owing to the strong and tight interlocking of the valves by the means of curved teeth and sockets, many species of Brachiopoda could open their valves but slightly. In some species, such as *Thecidium*, the animal could raise its dorsal valve at right angles to the plane of the ventral one (fig. 4).

In the Tretenterata, of which *Lingula* and *Discina* may

be quoted as examples, the myology is much more complicated, and anatomists have differed considerably in their respective views concerning the function of some of the muscles. They have been carefully described by Owen, Vogt, Hancock, Gratiolet Woodward, and others, and more



Figs. 23, 24.

Lingula anatina. 23, interior of ventral valve; 24, interior of dorsal valve (*after King*). *g*, umbonal muscular impressions (open valves); *h*, central muscles (close valves); *i*, transmedial or sliding muscles; *b*, parietal band; *j*, *k*, *l*, lateral muscles (*j*, anteriors; *k*, middles; *l*, outsiders), enabling the valves to move forward and backward on each other.

recently by King, whose views seem to carry with them a greater degree of plausibility. Of the shell or valvular muscles he makes out five pairs and an odd one, and individualizes their respective functions as follows:—Three pairs are *lateral*, having their members limited to the sides of the shell; one pair are *transmedians*, each member passing across the middle of the reverse side of the shell, while the odd muscle occupies the umbonal cavity. The *central* and *umbonal* muscles effect the direct opening and closing of the shell, the *laterals* enable the valves to move forward and backward on each other, and the *transmedians* allow the similar extremities (the rostral) of the valves to turn from each other to the right or the left on an axis subcentrically situated, that is, the medio-transverse region of the dorsal valve. It was long a matter in discussion whether the animal could displace its valves sideways when about to open its shell, but this has been actually observed by Professors Semper and Morse, who saw the animal perform the operation. They mention that it is never done suddenly or by jerks, as the valves are at

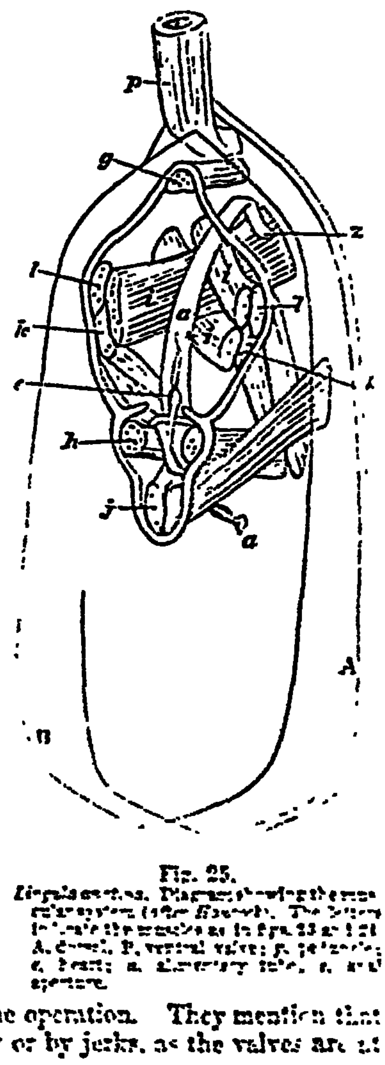


Fig. 25.

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first always pushed to one side several times and back again on each other, at the same time opening gradually in the transverse direction till they rest opposite to one another and widely apart. Those who have not seen the animal in life, or who did not believe in the possibility of the valves crossing each other with a slight obliquity, would not consent to appropriating any of its muscles to that purpose, and consequently attributed to all the lateral muscles the simple function of keeping the valves in an opposite position, or holding them adjusted. We have not only the observations of Semper and Morse, but the anatomical investigations of King, to confirm the sliding action or lateral divarication of the valves of *Lingula*.

In the Clistenterata, where no such sliding action of the valves was necessary or possible, no muscles for such an object were required, consequently none took rise from the lateral portions of the valves as in *Lingula*; but in an extinct group, the *Trimerellidæ*, which seem to be somewhat intermediate in character between the Tretenterata and Clistenterata, have been found certain scars, which appear to have been produced by rudimentary lateral muscles, but it is doubtful (considering the shells are furnished with teeth, though but rudely developed), whether such muscles enabled the valves, as in *Lingula*, to move forward and backward upon each other. We do not yet possess any reliable observations as to the manner in which *Discina* opens its valves, but Mr Barrett, who observed *Crania* in life, informs us that the valve opens by moving upon the straight hinge, without sliding the valve. There are muscles connected with other portions of the animal in both groups, such as the *parietal* muscles, strongly defined in the Tretenterata, and distinctive peculiarities of the peduncle, but the limited space at our disposal will not admit of entering upon further anatomical details.

Range of depth.

The Brachiopoda all inhabit the sea, and are supposed to have attained their full growth in a single season. A vast amount of important and accurate information has been collected during the past ten years with respect to the geographical distribution of recent species, as well as to the marine depths they inhabit or prefer. This important knowledge is mainly due to the numerous well conducted and equipped dredging expeditions carried on by private individuals and by the Governments of the leading maritime states. It would not be possible to give here the names of all those naturalists who have contributed to this portion of our information, but we cannot pass over those of Edward Forbes, J. G. Jeffreys, W. B. Carpenter, W. H. Dall, W. Thomson, E. Suess, A. Adams, H. Cuming, &c. Previous to these investigations the data we possessed with respect to the habitat and ranges of depth were in most cases vague and unsatisfactory. It has been ascertained that the Brachiopoda are much localized, and usually

sand by the sliding motion of the two valves, using at the same time the fringes of setæ, which swing promptly back and forth like a galley of oars, leaving a peculiar tract in the sand. In the motion of the setæ he noticed the impulse commencing from behind and running forward. *Discina* has been found attached to stones at low water mark, and dredged from depths ranging from 5 to nearly 2000 fathoms. They are very often clustered together in vast numbers, each adhering by its peduncle to the surface of the shell of its neighbour, one above the other, till they form a living mass of considerable breadth and thickness. *Crania* is found in great numbers adhering to stones and shells at depths of from 18 to 530 fathoms. The genera and species of the Clistenterata live at depths ranging from about half tide mark to that of 2600 fathoms. *Terebratulina caput serpentis* was found by the late R. T. Loweliviry attached to rocks at low water mark on a part of the Scottish coast, where the tide falls only a few feet, but the same species has been dredged alive from depths varying from 3 to upwards of 150 fathoms. Prof. Jukes got immense numbers of specimens of *Waldheimia flavescens* or *Australis* while boating in Australia among the reefs. They were merely washed by the tide, and he gathered them with his hand like limpets on the shore. M. Vélain picked up a small species of *Kraussina* in vast numbers on the shore in the interior crater of the island of St Paul, the shell being alternately covered with water and left dry at every tide. *Kraussina rubra*, from the coast of Natal in South Africa, was described by Dr Gray as having been found attached in great numbers to ascidia and stems of sea-weeds, and Mr Jeffreys had also previously noticed a small European species similarly fixed to sea-weeds. In general, however, it may be said that the larger number of species inhabit depths varying from 5 to 300 or 400 fathoms. Several species live attached to coral reefs. *Waldheimia cranium* has been obtained from depths varying from 160 to 228 fathoms. Barrett and Jeffreys state that *Terebratulina caput serpentis* manifested a remarkable power and disposition to move on its peduncle, and that it was incessantly opening and folding its brachial appendages, and drawing in and sucking in, by means of the whirlpool thus caused, every animalcula within its influence.

Classification. It is now necessary to say a few words with reference to the classification of the Brachiopoda, and in drawing up any scheme of arrangement due regard must be paid to the extinct forms, which vastly outnumber those of the present seas. The first species belonging to the class were imperfectly and quaintly described as well as figured by Fabio Columna as far back as 1606. Since then so many palæontologists have contributed to the elucidation of the fossil species that it would not be possible to give all their names; we must not, however, omit to record those of Linnæus, Defrance, Von Buch, Alcide D'Orbigny, De Blainville, Sowerby, Barrande, De Verneuil, Deslongchamps (father and son), De Koninck, E. Suess, W. King, F. M'Coy, J. Hall, Billings, Dalman, Dall, Fischer, Pander, C. Moore, Eichwald, Kutorga, Keyserling, Sandberger, Sequenza, Salter, Morris, Meek, and Davidson.

Various schemes of classification have been proposed, but none as yet can be said to be more than provisionally satisfactory, because before one can classify it is necessary to understand all the characters of the species one has to arrange in their more or less natural groups, and we are not yet in possession of all that necessary information.

In 1853 Davidson divided the Brachiopoda into eight families, comprising twenty-four genera and about as many sub-genera, but during the years that have elapsed from that to the present time, about seventy more genera and sub-genera have been described, so that as many as one hundred and twenty-three so-termed genera have now to be classed into their respective families, a task which has not yet been satisfactorily accomplished. It is, however, very probable that the number above given has been exaggerated, and that when our knowledge has increased, some of them will have to be placed among the synonyms.

It will be necessary in every scheme of classification to admit the two great divisions Tretenterata and Clistenterata.

The TRETENTERATA would comprise the families *Lingulidæ*, *Discinidæ*, *Craniadæ*, *Trimerellidæ*, and perhaps one or two others.

The CLISTENTERATA would include the families *Terebratulidæ*, *Thecidæidæ*, *Spiriferidæ*, *Rhynchonellidæ*, *Pentameridæ*, *Strophomeridæ*, *Orthidæ*, *Productidæ*, and perhaps two or three others that will have to be characterized. By far the larger number of described genera and species would find their place in this last great division and the above-named families. We will now very briefly notice some of the characters of the families above indicated.

TRETENTERATA—Family 1. *Lingulidæ*.—Shells generally either oblong or circular, with a peduncle, sometimes of considerable length, passing out between the valves or through a narrow channel in the hinge margin; texture horny; no calcified supports for the labial appendages; the fleshy spiral coils directed upwards. This family would comprise the following genera: *Lingula*, *Lingulella*, *Lingulops*, *Lingulepis*, *Glottidia*, *Monobolina*, *Obolus*, *Obolella*, *Dignomia*, *Schmidtia*, *Acritis*, *Volborthia*, &c. *Lingulella* is one of the oldest known types of animal life, while *Lingula* appeared for the first time about the middle of the Cambrian period, and has continued to be represented up to the present time.

Family 2. *Discinidæ*.—Shells more or less circular or oval shaped, attached by a peduncle passing through a foramen in the ventral valve; shell calcareous or horny; setæ extremely long, barbed with cilia of great length; labial appendages fleshy, curved backwards, with small terminal spire directed downwards as in *Crania* (fig. 11). Genera—*Discina*, *Trematis*, *Discinisca*, *Kutorgina* (?), *Acrotrata* (?), *Siphonotrata* (?). *Discina* appeared about the middle of the Cambrian period, and has continued to exist up to the present time.

Family 3. *Craniadæ*.—Shells orbicular or limpet-like, entirely free or attached by a greater or lesser extent of the under surface of their ventral valve; labial appendages spirally coiled, directed towards the bottom of the dorsal valve (fig. 11); shell calcareous, perforated by minute canals. Genera—*Crania*, *Craniops*, *Craniscus*, *Pholidops*. The genus *Crania* appeared for the first time during the Silurian period, and has continued to be represented up to the present time.

Family 4. *Trimerellidæ*.—Shells transversely or longitudinally oval; ventral valves usually the largest and flattest, with a more or less developed beak and area; ventral valves generally the most convex; hinge rudely or faintly dentary; all the genera are provided with a solid or vaulted muscular platform in the interior of both valves; no calcareous support for the labial appendages; shell calcareous, and in two of the genera very massive. All the forms are extinct. Genera—*Trimerella*, *Monomerella*, *Dinobolus*. The species of this family are restricted to the Silurian period.

CLISTENTERATA—Family 5. *Terebratulidæ*.—Shells very variable in shape, with a prominent beak, truncated by a circular perforation, partly completed by a deltidium in one or two pieces; labial appendages united to each other by a membrane, variously folded upon themselves, and in some genera spiral at their extremities. These appendages are entirely or partially supported by a calcified process,

assuming great variety of shape (figs. 1, 12 to 20, and 22). All the species lived attached to submarine bodies by the means of a peduncle. Shell structure punctated. Genera —*Terebratula, Terebratulina, Terebratella, Waldheimia, Megerlia, Kraussina, Kingina, Terebrirostra, Magas, Mannia, Bouchardia, Platidia, Argiope, Cistella, Reusselaria, Zellania, Gwynia, Macandrevia, Diclasma, Megantheris, Stringocephalus, Tropidolepis* (?). *Terebratula* appeared at the conclusion of the Silurian period, and continues to be represented up to the present time, but the larger number of genera have had a very limited distribution in time.

Family 6. *Thecidœdæ*.—Shells small, thick, varied in shape, attached by a larger or smaller portion of the shell substance of their ventral valve; area flat; deltidium indistinct; valves articulated; loop in the dorsal valve folded into two or more lobes lying in hollows of corresponding shape excavated in the substance of the valve (figs. 3, 4). This loop, or apophysary ridge, supports the brachial membrane, whose thickened cirrated margin is apparently attached to the inner sides of the grooves; shell structure punctated. Only one genus, *Thecidium*. It appeared in the Trias, and has continued to be represented up to the present time.

Family 7. *Spiriferidæ*.—Shells variable in shape, ovate, elongated or transverse trilobed, with the hinge-line at times straight and extended into wing-shaped expansions; valves articulated, with or without a flattened area in ventral valve; animal free or attached during at least a portion of its existence by the means of a peduncle, or by muscular fibres issuing from an angular or circular foramen in the beak or area of the ventral valve; dorsal valve internally furnished with two calcareous spiral processes, connected in different manners, and directed outwards towards the sides of the shell (fig. 5). These processes afforded support to the brachial appendages. This family composes the following impunctate or punctate genera: *Spirifera, Cyrtia, Spiriferina, Cyrtina, Martinia, Athyris, Merista, Meristina, Retzia, Nucleospira, Trematospira, Rhynchospira, Meristella, Zygospira, Coelospira, Rhynchoema, Uncites, Ambocœlia, Charionella, Syringothyris, umetria, Suessia, Vetulina* (?). The first species belong g to this family made its appearance during the Silurian eriod, and the family became entirely extinct in the nferior Oolite.

Family 8. *Rhynchonellidæ*.—Valves articulated, very ariable in shape, more or less trigonal, often trilobed or vate, smooth or plicated (fig. 2); foramen beneath a sually produced and pointed beak, completed by a eltidium at times concealed; brachial appendages fleshy nd spirally rolled, flexible, and supported only at their rigin by a pair of short-curved shelly processes, or hroughout by two broad spirally-coiled lamellæ (these pires are vertical, closely appressed, and directed towards he centre of the valve); shell structure fibrous and npunctate. This family composes the following genera: *Rhynchonella, Atrypa, Eatonia, Leptocœlia, Brachymerus, nastrophia, Leiorhynchus, Camarophoria, Rhynchopora, Rhynchonellina*, and one or two others. The first species ppeared during the Silurian period, and representatives the family have continued to the present time.

Family 9. *Pentameridæ*.—Shells ovate, somewhat entagonal; valves articulated, without hinge-area; ramen angular; no deltidium; inside of ventral valve wo contiguous vertical septa of greater or lesser length, which coalesce into one median plate, and then diverge to rm the dental plates, enclosing a triangular trough-like amber. In the interior of dorsal valve are two longitu-nal septa of variable dimensions, to which the socket walls nverge and which they join, forming two more or less de-ed and inclined plates, to the produced extremities of which were no doubt affixed the fleshy spiral labial appendages. Shell structure impunctate. Genera—*Pentamerus, Pentamerella*, and perhaps one or two others. The species of this family are limited to the Silurian, Devonian, and Carboniferous periods.

Family 10. *Strophomenidæ* (figs. 6, 7).—Shells semicircular, transverse, or elongated; valves usually concavo-convex, regularly arched, geniculated or depressed, so that the valve which is convex in some species is concave in others, and *vice versa*; hinge-line long, straight; area in ventral valve flat, with a fissure partly arched over by a pseudo-deltidium, while the extremity of the beak is either entire or perforated by a small circular foramen. In the dorsal valve the projecting bifid cardinal process fills up almost the entire cavity of the fissure that may not have been arched over by the pseudo-deltidium of the opposite valve. Valves sometimes uniformly convex, the dorsal one sometimes depressed with an area divided by a triangular foramen. In the interior of the dorsal valve a small, simple, projecting cardinal process is situated between prominent socket walls, to the inner extremities of which were (probably) attached the brachial appendages. Genera —*Strophomena, Streptorhynchus, Strophodonta, Leptæna, Orthis, Orthesina, Skenidium, Brachyprion, Discolosia, Meekella, Davidsonia* (?), and several others. The first species appeared during the Silurian period, and the last in the upper Lias. It may, however, be necessary to group the genera provisionally placed in the *Strophomenidæ* into one or two families or sub-families. A family *Orthidæ* might be established. *Strophomena* differs from *Orthis* in having a closed fissure, and the cardinal process bifid or trilobed, while in *Orthis* it is generally formed of one piece. In *Strophomena* it is situated directly between the dental sockets, or has between them and it a small prominent ridge, or brachial process; for this last is scarcely developed, where it exists, and forms a marked contrast to what we find in the same valve of *Orthis*. There are also four more or less distinctly defined adductor depressions, which are longitudinally parallel to each other, and separated by ridges, while in *Orthis* these four divisions are placed in pairs one above the other.

Family 11. *Productidæ*.—Shells more or less concavo-convex, oval, semi-oval, or angular and generally auriculated; the hinge-line straight, with or without teeth and sockets for the articulation of the valves (fig. 8); surface of ventral valve or hinge-line more or less furnished with tubular spines, sometimes of considerable length; no calcareous processes for the support of the brachial appendages; shell structure perforated by canals; cardinal process prominent, bilobed or trilobed. Under this a narrow longitudinal ridge generally extends to about half (or more) of the length of the valve, and on each side are seen the ramified dendritic impressions, which may be attributable to the adductor muscle. Outside, and in front of these, are the two reniform impressions so characteristic of the family. Genera—*Productus, Strophalonia, Aulosteges, Chonetes, Productella*. The *Productidæ* made their first appearance during the Silurian time, and became extinct at the close of the Palæozoic period.

Assuming that the reader is acquainted with the geological divisions into which the earth's crust has been grouped, it may be observed that the Brachiopoda, after the Trilobites, occupy the most important place in the Cambrian or Primordial fauna. Thus, in 1871, out of 241 species known to Barrande as composing the animal kingdom of that period, 179 are referable to the Trilobites and other Crustaceans, 28 to the Brachiopoda, while 34 species would be divided between the Annelida, Pteropoda, Gasteropoda, Bryozoa, Cystidians, and Sponges. Subsequently to these researches several additional species of

Trilobites and Brachiopoda have been added to the list through the indefatigable exertions of Prof. Linnarsson, Mr Hicks, and others. The Brachiopoda, along with the groups mentioned by Barrande, are in all probability the earliest representatives of life at present known; for Mr Hicks has obtained undoubted examples of *Lingula* or *Lingulella* (*L. primæva*) from the very base of the whole Cambrian series of St David's in Wales. It is impossible for the present to offer more than an approximate comparison, based on numbers, of the genera and species that have existed during the various geological more or less extended periods; and many years will have to pass away before some master mind will be able to grapple with the accumulated observations of a century or more, and reduce the number of genera and species within reasonable limits, from which something like reliable data may be formed. Lyell has stated that nothing is more remarkable in the Silurian strata generally of all countries than the preponderance of the Brachiopoda over other forms of Mollusca. Their proportional numbers can by no means be explained by supposing them to have inhabited seas of great depth, for the contrast between the Palæozoic and the present state of things has not been essentially altered by the late discoveries made in our deep-sea dredgings. We find the living Brachiopoda so rare as to form about one forty-fourth of the whole bivalve fauna, whereas in the Lower Silurian rocks, and where the Brachiopoda reach their maximum, they are represented by more than twice as many species as the Lamellibranchiate bivalves. There may indeed be said to be a continuous decrease of the proportional number of this lower tribe of Mollusca as we proceed from the older to the newer rocks. Owing to the great number of synonyms it would not be possible at present to offer even an approximate statement with reference to the number of known species. Bigsby states that some 1754 species of Cambrian, Silurian, Devonian, and Carboniferous species of Brachiopoda have been found in America; 1905 in Europe. It is probable that as many as between four or five thousand species of Brachiopoda have been described, and it is noteworthy that the species, so immensely abundant during the Cambrian, Silurian, Devonian, and Carboniferous periods, became much less numerous during the Permian and Triassic, while they again became abundant, although comparatively reduced in number, during the Jurassic and Cretaceous periods. In the Tertiaries they had materially decreased in number, and they are represented at the present time by about 100 species. It has also been clearly ascertained that a certain number of genera and species passed from one system or formation into the one that followed it. Thus, approximately, it may be said that nine genera appeared for the first time in the Cambrian system, fifty-two in the Silurian, twenty-one in the Devonian, seven in the Carboniferous, two in the Permian, three in the Triassic, eleven in the Jurassic, five in the Cretaceous, three in the Tertiary, and nine in the recent periods. But what wonderful changes have been operating during the incalculable number of ages in which the creation and extinction of a large number of genera and thousands of species have taken place,—some few only of the primordial or first created genera, such as *Lingula*, *Discina*, and *Crania*, having fought their way and struggled for existence through the entire sequence of geological time. Many were destined to comparatively ephemeral duration, while others had a greater or lesser prolongation of existence.

The importance of the study of the Brachiopoda must be obvious to all. They are, as already stated, among the first well-known indications of life in this world, and they have continued to be very extensively represented up to the present time. They are also very characteristic fossils by which rocks at great distances, whether in New Zealand or Spitzbergen, in the Himalayas or the Andes, can be identified, without its being even necessary for the Palæontologist to visit the district whence the fossils are derived; they are, as Mantell would have termed them, sure medals of creation, the date of their appearance firmly stamped upon them, and their distinctive characters so legibly impressed as to defy misinterpretation. (T. D.)

BRACHYLOGUS, a title applied, for the first time in the middle of the 16th century, to a work which contains a systematic exposition of the Roman law, and which some writers have assigned to the reign of the Emperor Justinian, and others have treated as an apocryphal work of the 16th century. The earliest extant edition of this work was published at Lyons in 1549, under the title of *Corpus Legum per modum Institutionum*; and the title *Brachylogus totius Juris Civilis* appears for the first time in an edition published at Lyons in 1553. The origin of the work may be referred with great probability to the 12th century. There is internal evidence that it was composed subsequently to the reign of Louis le Débonnaire, as it contains a Lombard law of that king's, which forbids the testimony of a clerk to be received against a layman. On the other hand its style and reasoning is far superior to that of the law writers of the 10th and 11th centuries; whilst the circumstance that the method of its author has not been in the slightest degree influenced by the school of the Gloss-writers (Glossatores) leads fairly to the conclusion that he wrote before that school became dominant at Bologna. Savigny, who has traced the history of the *Brachylogus* with great care, is disposed to think that it is the work of Irnerius himself. Its value is chiefly historical, as it furnishes evidence that a knowledge of Justinian's legislation was always maintained in Northern Italy. The author of the work has adopted the *Institutes* of Justinian as the basis of it, and draws largely on the *Digest*, the *Code*, and the *Novells*; whilst certain passages, evidently taken from the *Sententiæ Receptæ* of Julius Paulus, imply that the author was also acquainted with the Visigothic code of Roman law compiled by order of Alaric II. An edition by Professor Bocking was published at Berlin in 1829, under the title of *Corpus Legum sive Brachylogus Juris Civilis*.

BRACTON, HENRY DE, a learned ecclesiastic, who was chief justiciary in the reign of Henry III. He is supposed to have been born at Bratton-Clovelly in Devonshire. He studied at Oxford, where he took the degree of doctor of laws, and is believed to have delivered lectures in that university. He was appointed a justice itinerant for the counties of Nottingham and Derby in 1245, and his name appears as a justiciary or judge of the Aula Regis on the Fine Rolls in 1249 and in each of the next seventeen years, written indifferently Bratton and Bretton, which circumstance has led Selden and others to attribute to him the authorship of the earliest treatise on the law of England in the French tongue, known as Bretone or Bretoun. In 1254 the king assigned to him by letters patent, in which he was designated "dilectus clericus noster," the use of a house in London belonging to William late earl of Derby during the minority of the heir, and in 1263 he was collated to the archdeaconry of Barnstaple. This office, however, he resigned in the following year; and in 1265 he was appointed chief justiciary, and held that office until the end of 1267, when all notice of him ceases. He wrote

a most comprehensive and systematic work on the laws of England in five volumes, entitled *De Legibus et Consuetudinibus Angliæ*, which is modelled after the *Institutes* of Justinian, and is supposed, from internal evidence, to have been completed about the time when he was appointed chief justiciary, as it contains references to changes in the law made shortly before that time, but takes no notice of the statute of Marlborough passed in 52 Henry III. A Latin abridgment of Bracton's work was written by Gilbert de Thornton, who was appointed Chief-Justice of the King's Bench in the 17th year of the reign of Edward I., of which Selden possessed a copy, but no copy of it is at present known to exist. There are numerous MSS. extant of Bracton's work, but only two editions of it have been printed, the first in folio in 1569, the second in quarto in 1640. The text of these editions is identical, as well as the paging.

BRADFORD, a parliamentary and municipal borough of England, situated in the northern division of the West Riding of Yorkshire and the wapentake of Morley, on an affluent of the Aire, 34 miles S.W. of York, 9 miles W. of Leeds, and 192 miles from London by rail. The borough comprises 7220 acres, and is divided into five townships —Bradford, Manningham, Horton, Bowling, and Bolton. Bradford has returned two members to parliament since 1832, was incorporated in 1847, and is governed by a mayor, 15 aldermen, and 45 councillors. The parish includes the thirteen townships of Allerton, Bowling, Bradford, Clayton, Eccleshill, Haworth, Heaton, Horton, Manningham, North Bierley, Shipley, Thornton, and Wilsden, and comprises 34,146 acres. The population of the borough in 1871 was 145,830,—68,905 males and 76,925 females.

During the Saxon period Bradford was included in the parish of Dewsbury; but William the Conqueror, who mentions it in *Domesday Book*, included it in the barony of Pontefract, which he granted to Ilbert de Lacy. The manor of Bradford remained in the hands of the De Lacies until the beginning of the 14th century, when it passed by marriage to the family of the earl of Lancaster, John of Gaunt holding it at the time of his death in 1399. The manor was held by the Crown from that time down to the reign of Charles I., who sold it for a small yearly rent to the corporation of London. Afterwards it passed into the possession of the Marsdens of Hornby Castle, but since 1795 it has been held by the Rawson family, from whom the corporation have recently purchased all manorial rights. In great rapidity. The first mill in Bradford was built in 1798; there were 20 mills in the town in 1820, 34 in 1833, and 70 in 1841; and at the present time there are between 200 and 300, of much greater magnitude than the earlier factories. In the seventy years between 1801 and 1871 the population of the town increased tenfold, during which period the worsted trade has been developed to an astonishing extent. In 1833 Mr (now Sir Titus) Salt developed the alpaca manufacture in the town; mohair was shortly afterwards introduced; and more recently Mr S. C. Lister has introduced the silk and velvet manufacture, having invented a process of manipulating silk waste, whereby what was previously treated as refuse is made into goods that will compete with those manufactured from the perfect cocoon. In the Bradford staple trade alone it is estimated that there is now an annual turn-over of between £60,000,000 and £70,000,000.

Bradford has been greatly improved in appearance during the last few years, many important public buildings having been erected, and new and spacious thoroughfares opened out where narrow and ungainly streets formerly existed. Amongst the more prominent public buildings may be mentioned—St George's Hall, used for public meetings, concerts, &c., and capable of accommodating nearly 4000 persons, built in 1853; the Exchange, built in 1867, at a cost of £40,000; the market buildings, opened in 1872, and the Town-Hall, opened in 1873, and built at a cost of £100,000. The town is built entirely of the freestone which is so plentiful in the district. Many of the warehouses are large and of considerable architectural beauty, and the factories are mostly of great extent, some single establishments giving employment to between 3000 and 4000 workpeople.

The parish church, built in 1485, on the site of an old Norman church, is dedicated to St Peter. The living is valued at £1300 per annum. There was no other church in the town until 1815, when Christ Church was built. In 1838 St James's Church was erected, and between that date and 1853 five others were built. More recently ten additional churches have been built by the Bradford Church Building Society, the last of the ten (St Bartholomew's) being opened in 1872. There are now over twenty churches in the town. The dissenters have upwards of forty places of worship in Bradford, many of which are large and handsome edifices. The Roman Catholics likewise possess several churches.

Park and Lister Park,—each comprising over 50 acres, and also two smaller parks. The first temperance hall in England was erected at Bradford in 1837. There are two court-houses for the holding of the county and West Riding courts; the borough court is held in the town-hall. Numerous political and social clubs flourish in the town. Three daily and four weekly papers are published. Statues of the late Sir Robert Peel and Richard Oastler, "the factory king," were put up in advantageous positions some years ago; and recently the statues of two local commercial celebrities, Sir Titus Salt and Mr S. C. Lister, have been erected. Bradford has communication with all parts of the country by the Midland, Great Northern, Lancashire and Yorkshire, and London and North-Western Railways. A branch canal in connection with the Leeds and Liverpool canal was opened in 1774, but in 1871 it was closed by injunction, in consequence of the polluted condition of its water. Since then, however, it has been purified and re-opened.

In addition to its extensive operations in connection with the worsted trade, Bradford is largely engaged in the machine, stone, coal, and iron trades. The well-known Bowling and Low Moor Ironworks are within a short distance of the town. Formerly a septennial festival was held at Bradford in honour of Bishop Blaize, the patron saint of the wool-combers, but after 1825 it was discontinued. The market days are Monday and Thursday.

BRADFORD, JOHN, was born at Manchester in the early part of the reign of Henry VIII. Being a good penman and accountant, he became secretary to Sir John Harrington, who was paymaster of the English forces in France. Bradford at this time was gay and thoughtless, and to support his extravagance he appropriated some of the money entrusted to him; but being unable to bear the load of his guilt, he made restitution, and relinquished his employment. About 1547 he took chambers in the Inner Temple, and began to study law; but finding divinity more congenial to his taste, he removed, in the following year, to Catherine Hall, Cambridge, where he studied with such assiduity that in little more than a year he was admitted to the degree of master of arts, and was soon after made fellow of Pembroke Hall. Bishop Ridley, who in 1550 was translated to the see of London, sent for him to the metropolis and appointed him his chaplain. In 1553 he was also made chaplain to Edward VI., and became one of the most popular preachers in the kingdom. Soon after the accession of Mary he was arrested on a charge of sedition and confined in the Tower, where he continued a year and a half. During this time he wrote several epistles which were dispersed in various parts of the kingdom. He was afterwards removed to Southwark, and was at last brought to trial before the court in which Gardiner sat as chief, where he defended his principles to the last, in defiance of all attempts to effect his conversion. He was condemned to the flames, and suffered in Smithfield, July 1, 1555. His writings, which consist chiefly of sermons, meditations, tracts, letters, and prayers, have been published in 12mo by the Religious Tract Society.

BRADLEY, DR JAMES, one of the most eminent British astronomers, was born at Sherborne in Gloucestershire in March 1692. He entered Balliol College, Oxford, in 1710, and graduated as B.A. in 1714 and as M.A. in 1717. At the house of his uncle, the Rev. James Pound, himself known as an acute observer, he had found instruments and means for carrying on a regular series of astronomical observations. He became a member of the Royal Society in 1718, and though he took orders in the following year, and was presented to the vicarage of Bridstow, he did not give up his scientific pursuits. He also obtained a small sinecure living in Wales, but in 1721, on his appointment to the Savilian professorship of astronomy at Oxford, he resigned all his ecclesiastical preferments. In 1727 he communicated to the Royal Society his great paper on aberration, a remarkable combination of exact observation and profound induction. Some years afterwards Bradley began his lectures at the Oxford Museum, and in 1742 he was appointed to succeed Harley as astronomer royal. In 1747 his minute observations led him to the second of his great discoveries, the nutation of the earth's axis. The remainder of Bradley's life was devoted to the Greenwich Observatory. In 1748 he succeeded in getting a small grant for instruments from the public funds, and in 1752 he was rewarded with a pension of £250. He continued his labours till 1761, when his health began to give way. He then retired into the country and died at Chalford, Gloucestershire, in July 1762. The immense mass of useful observations left by him at Greenwich was singularly neglected by English astronomers; but since Bessel presented them in systematic form to the world (see BESSEL, vol. iii. p. 616) their true value has been recognized. For an account of Bradley's scientific discoveries see ASTRONOMY and ABERRATION.

Copious information as to Bradley's life and works will be found in Prof. Rigaud's Memoir prefixed to *Miscellaneous Works and Correspondence of the Rev. James Bradley*, 1832.

BRADSHAW, HENRY, an English poet, born at Chester about the middle of the 15th century. Early displaying a taste for religion and literature, he was received while a boy into the Benedictine monastery of St Werberg in that city; and he was afterwards sent to Gloucester (now Worcester) College, Oxford. After studying there for a time with the novices of his order he returned to his convent, where, in the latter part of his life, he applied himself chiefly to the study of history. He died in 1513. His poetry in some respects is not inferior to that of any of his contemporaries. His works are,—(1), *De antiquitate et magnificentia Urbis Cestriæ;* (2), *Chronicon;* (3), *The Life of the Glorious Virgin St Werberg*, printed at London, 1521, 4to, in verse, and now extremely rare. The life of St Werberg forms only part of this work, which contains also a description of the kingdom of Mercia, a life of St Etheldred, a life of St Sexburg, the foundation and history of Chester, and the chronicles of some kings.

BRADSHAW, JOHN, president of the High Court of Justice which tried Charles I., appears to have been born in 1602 at Marple Hill, near Stockport in Cheshire. He was of good family, and is believed to have been connected with Milton, the mother of the latter having married a Bradshaw. At all events, whether connected or not, the two knew and respected each other. Milton gives a highly eulogistic account of Bradshaw's character in his *Defensio Secunda*, and Bradshaw left by will £10 to Milton. His education seems to have been carried on at Stockport free school, and afterwards at Bunbury and Middleton. He was called to the bar at Gray's Inn in April 1627, and in 1645 became a bencher. For some time he acted as judge in the Sheriff-Courts of London. As a lawyer he had considerable chamber practice, especially among those whom Clarendon calls the "factious." In 1644 he was employed by Parliament as one of the prosecutors of the Irish Lords Macguire and Macmahon. In October 1646 he was voted by the Commons as one of the commissioners of the Great Seal, and in March of the following year he was appointed chief-justice of Cheshire. On October 12, 1648, he was raised to the rank of serjeant. In January 1649, when it was found difficult to compose a court of justice for the trial of the king, Bradshaw was proposed as president, and at once elected. His demeanour on the trial is well known, but has been variously judged. He continued to retain the title of Lord President for some time after the trial,

and received large rewards from Parliament for his valuable services. On the formation of a council of state Bradshaw was elected a member, and for three years held office as president. After that time the presidents were elected in rotation, and held their appointment for a month. When, on the 20th April 1653, Cromwell, after dismissing the Parliament, came to dissolve the council, Bradshaw is said to have confronted him boldly, and denied his power to dissolve the Parliament. This story rests on the authority of Ludlow, who was not a witness, and who does not say that Bradshaw was president of the council on that occasion. Bradshaw, an ardent republican, ever afterwards showed himself an uncompromising adversary of Cromwell. He was returned for Cheshire in the Parliament of 1654, and spoke strongly against vesting the power in a single person. He refused to sign the "engagement" drawn up by Cromwell, and in consequence withdrew from Parliament. Some time afterwards he was concerned with Harrison and others in one of the numerous republican conspiracies, and it has even been suspected that he was at least cognizant of some of the fifth monarchy men's desperate plots. He failed to obtain a seat in the Parliament of 1656, and on 1st August of the same year Cromwell ordered him to be dismissed from the chief-justiceship of Chester. It is not quite certain that this order was carried out. After the abdication of Richard Cromwell, Bradshaw again entered Parliament and became a member of the council of state. His health, however, was bad, and his last public effort was a vehement speech on the seizure of Speaker Lenthall, in which he denounced the military despotism of the time. He died on the 22d November 1659, and was buried in Westminster Abbey. His body was disinterred at the Restoration, and exposed on a gibbet along with those of Cromwell and Ireton. Bradshaw's character will be found very differently drawn by Clarendon (*History of the Rebellion*, bk. xi.) and Milton (*Defensio Secunda*).

See Foss, *Lives of Judges*; Ormerod's *Chester*, iii. 408-9; *Beauties of England and Wales*, ii. 264, sqq.; Noble, *Lives of the English Regicides*, vol. i.; Caulfield, *High Court of Justice*; Godwin.

zealous promoter of the Revolution and suffered in consequence. When the troubles broke out in Ireland in 1690, Brady, by his influence, thrice prevented the burning of the town of Bandon, after James II. had given orders for its destruction; and the same year he was employed by the people of Bandon to lay their grievances before the English parliament. He soon afterwards settled in London, where he obtained various preferments. At the time of his death in 1726 he held the livings of Clapham and Richmond. Besides his version of the Psalms, which was licensed in 1696, he translated Virgil's *Æneid*, and wrote several smaller poems and dramas. His prose works consist of sermons.

BRAGA, a city of Portugal, capital of a district in the province of Minho, is situated on an elevated plain near the River Cavado (*Nabis*), in 41° 43′ N. lat. and 8° 16′ W. long. The city proper, which has extensive suburbs, is surrounded by walls and towers, and has broad and well-built streets. The cathedral, which dates from the 12th century, is an imposing structure, and contains a large number of interesting objects of art. Among the other churches Santa Cruz is pre-eminent. There are also several convents in the city, an archiepiscopal palace, a lyceum, a library, an orphan asylum, and a large hospital; also the ruins of a theatre, a temple, and an aqueduct of Roman workmanship, and a great variety of minor antiquities of different ages. The principal manufactures are fire-arms, jewellery, and cutlery; and weaving and wax-bleaching are also carried on. A large cattle market is held in June and September. About two and a half miles distant is the celebrated sanctuary of Jesus de Monte, to which pilgrimages are frequently made. Population, 18,467.

Braga is identified with the *Bracara Augusta* of the Romans, the capital of the Callaici Bracarii. About the 5th century it became the chief city of the Suevi; it passed successively into the hands of the Goths and the Moors, and was captured from the latter by Alphonso of Castile. It has for a long time been the seat of the primate of Portugal, who also claimed to be head of the Spanish church, and before the conquest of Coimbra and Lisbon it was the residence of the Portuguese court.

and was universally recognized as being without a rival even in that land of song. In 1801 he returned to his native country, and appeared once more at Covent Garden in the opera *Chains of the Heart* by Mazzinghi and Reeve. So great was his popularity that an engagement he had made when abroad to return after a year to Vienna was renounced, and he remained henceforward in England. For nearly forty years from this date his powers continued unimpaired, and he sang occasionally in public till within a year or two of his death, which occurred on the 17th February 1856. There is, perhaps, no other case upon record in which a vocalist of the first rank enjoyed the use of his organ so long; between his first and last public appearances considerably more than sixty years intervened, during forty of which he held the undisputed supremacy alike in opera, oratorio, and the concert-room. Braham was the composer of a number of vocal pieces, which being sung by himself had great temporary popularity, though they had little intrinsic merit, and are now deservedly forgotten. A partial exception must be made in favour of *The Death of Nelson*, which still keeps its place as a standard popular English song.

BRAHE, TYCHO, an illustrious astronomer, descended from a noble family, of Swedish origin, which had settled in Denmark, was born on the 14th December 1546, at Knudstorp, in the county of Schonen. He learned Latin at the age of seven, and studied five years under private tutors. On the death of his father his uncle sent him, in April 1559, to study philosophy and rhetoric at Copenhagen. The great eclipse of the sun, on the 21st of August 1560, happening at the precise time foretold by astronomers, he began to look upon astronomy as something divine; and having purchased the *Ephemerides* of Stadius, he gained some knowledge of the theory of the planets. In 1562 he was sent by his uncle to Leipsic to study law; but astronomy wholly engrossed his thoughts, and he employed all his pocket-money in purchasing books on that science. Having procured a small celestial globe, he used to wait till his tutor went to bed, in order to examine the constellations and learn their names; and when the sky was clear, he spent whole nights in viewing the stars. He returned to Denmark in 1565, but soon left for Wittenberg, whence he was driven by the plague to Rostock. There in the following year his choleric disposition involved him in a duel with a Danish nobleman, in which he had the misfortune to lose part of his nose; but this defect he so skilfully supplied by means of gold, silver, and wax, that it was scarcely perceptible. In 1569 he took up his residence at Augsburg and remained there two years, busily engaged in astronomical and chemical researches. In 1571 he returned to Denmark, and was favoured by his maternal uncle Steno Belle with a convenient place at his castle of Herritzvad near Knudstorp for making his observations, and building a laboratory. But his marrying a peasant girl occasioned a violent quarrel between him and his relatives, and the king was obliged to interpose in order to reconcile them. In 1574, by royal command, he read some lectures at Copenhagen; and the year following he began his travels through Germany, and proceeded as far as Venice. He then resolved to remove his family, and settle at Basel; but Frederick II., unwilling that Denmark should lose the honour of his residence, bestowed upon him for life the Island of Huen in the Sound, for the erection of an observatory and laboratory, and conferred on him a fee in Norway, a pension of two thousand crowns out of the treasury, and the canonry of Roschild, which brought him a thousand more. The first stone of the observatory was laid on the 8th of August 1576. James VI. of Scotland, afterwards James I. of England, on his visit to Denmark to marry the Princess Anne, went to see Tycho Brahe in his retirement at Uranienburg, made him several presents, and wrote some verses in his praise. Soon after the death of King Frederick, the astronomer was deprived of his pension, fee, and canonry. Finding himself unable to defray the expenses of his observatory he went to Copenhagen, whither he carried some of his instruments, and continued his astronomical observations in that city, till, by the order of Christian IV., he was obliged to discontinue them. He then removed his family to Rostock, and afterwards to Holstein in order to solicit Henry Ranzau to introduce him to the emperor; and accordingly he was received by Rudolph II. at Prague with the most gratifying marks of respect. That prince gave him a magnificent house till he could procure for him one better fitted for astronomical observations, assigned him a pension of three thousand crowns, and promised, upon the first opportunity, a fee for him and his descendants. But he did not long enjoy his good fortune; for, on the 24th of October 1601, he died of a strangury, in the 55th year of his age. He was interred in a magnificent manner in the principal church at Prague, where a noble monument was erected to his memory. Shortly before his death he had been joined by Kepler, who owes his fame to the lessons of careful observation and cautious inference impressed on him by Tycho.

The materials for Brahe's life are to be found in Gassendi, *Vita T. Brahei*, 1654. For later surveys of his life and labours, see Delambre, *Astronomie moderne*; Lalande, *Bibliographie astronom.*; Bertrand, *Les Fondateurs de l'Astronomie moderne*; Brewster, *Martyrs of Science*. For Brahe's contributions to astronomy, see Grant, *History of Physical Astronomy*, and the article ASTRONOMY.

BRÁHMA SAMÁJ, the new theistic church in India, owes its origin to Rájá Rám Mohan Rái, one of the leading men whom India has produced in later times. Rám Mohan Rái was born in the district of Bardwán in 1772. He mastered at an early age the Sanskrit, Arabic, and Persian languages. Impressed with the fallacy of the religious ceremonies practised by his countrymen, he impartially investigated the Hindu Shastras, the Koran, and the Bible, repudiated the polytheistic worship of the Shastras as false, and inculcated the reformed principles of monotheism as found in the ancient Upanishads of the Vedas. In 1816 he established a society, consisting only of Hindus, in which texts from the Vedas were recited and theistic hymns chanted. This, however, soon died away on account of the opposition it met from the Hindu community. In 1830 the Rájá organized a Hindu society for prayer-meetings, which may be considered as the foundation of the present Bráhma Samáj. The following extract from the trust-deed of the building dedicated to it will show the religious belief and the purposes of its founder. The building was intended to be "a place of public meeting for all sorts and descriptions of people, without distinction, who shall behave and conduct themselves in an orderly, sober, religious, and devout manner, for the worship and adoration of the eternal, unsearchable, and immutable Being, who is the author and preserver of the universe, but not under and by any other name, designation, or title, peculiarly used for and applied to any particular being or beings by any man or set of men whatsoever; and that no graven image, statue, or sculpture, carving, painting, picture, portrait, or the likeness of anything shall be admitted within the said messuage, building, land, tenements, hereditament, and premises; and that no sacrifice, offering, or oblation of any kind or thing shall ever be permitted therein; and that no animal or living creature shall within or on the said messuage, &c., be deprived of life either for religious purposes or food, and that no eating or drinking (except such as shall be necessary by any accident for the preservation of life), feasting, or rioting be permitted

therein or thereon; and that in conducting the said worship or adoration, no object, animate or inanimate, that has been, or is, or shall hereafter become or be recognized as an object of worship by any man or set of men, shall be reviled or slightingly or contemptuously spoken of or alluded to, either in preaching or in the hymns or other mode of worship that may be delivered or used in the said message or building; and that no sermon, preaching, discourse, prayer, or hymns be delivered, made, or used in such worship, but such as have a tendency to the contemplation of the Author and Preserver of the universe, or to the promotion of charity, morality, piety, benevolence, virtue, and the strengthening of the bonds of union between men of all religious persuasions and creeds." The new faith at this period held to the Vedas as its basis. Rám Mohan Rái soon after left India for England, and took up his residence in Bristol, where he died in 1835. The Bráhma Samáj maintained a bare existence till 1841, when Bábu Debendra Náth Tagore, of the Tagore family of Calcutta, devoted himself to it. He gave a printing-press to the Samáj, and established a monthly journal called the *Tattwabodhiní Patriká* to which the Bengali language now owes much for its strength and elegance. About the year 1850 some of the followers of the new religion discovered that the greater part of the Vedas is polytheistic, and a schism took place,—the advanced party holding that nature and intuition form the basis of faith. Between the years 1847 and 1858 branch societies were formed in different parts of India, especially in Bengal, and the new church made rapid progress, for which it was largely indebted to the spread of English education and the labours of the Christian missionaries.

The Bráhma creed was definitively formulated as follows. (1.) The book of nature and intuition supplies the basis of religious faith. (2.) Although the Bráhmas do not consider any book written by man the basis of their religion, yet they do accept with respect and pleasure any charity, and the cultivation of devotional feelings are their rites and ceremonies. They further say, Govern and regulate your feelings, discharge your duties to God and to man, and you will gain everlasting blessedness; purify your heart, cultivate devotional feelings, and you will see Him who is unseen. (14.) Theoretically there is no distinction of caste among the Bráhmas. They declare that we are all the children of God, and therefore must consider ourselves as brothers and sisters.

For long the Bráhmas did not attempt any social reform. But about 1860 the younger Bráhmas, headed by Bábu Kesab Chandra Sen, tried to carry their religious theories into practice by excluding all idolatrous rites from their social and domestic ceremonies, and by rejecting the distinction of caste altogether. This, however, the older members opposed, declaring such innovations to be premature. The theoretical schism now widened into a visible separation, and henceforth the two parties of the Bráhmas were known as the Conservatives and the Progressives. The progressive Bráhmas, or, as they call their church, the "Bráhma Samáj of India," have made considerable progress. They have built a chapel in Calcutta, which is crowded every Sunday evening; and they encourage the establishment of branch Samájes in different parts of the country. The number of avowed Bráhmas probably does not exceed 3000, but the greater part of the educated natives of Bengal sympathize more or less with the movement. (W. W. H.)

BRAHMANISM is a term commonly used to denote a system of religious institutions originated and elaborated by the *Bráhmans*, the sacerdotal and, from an early period, the dominant caste of the Hindú community. In like manner, as the language of the Áryan Hindús has undergone continual processes of modification and dialectic division, so their religious belief has passed through various stages of development broadly distinguished from one another by certain prominent features. The earliest phases of religious thought in India of which a clear idea can now

earliest lyrical effusions of the Āryan settlers in India which have been handed down to posterity. They are certainly not all equally old; on the contrary they evidently represent the literary activity of many generations of bards, though their relative age cannot as yet be determined with anything like certainty. The tenth and last book of the collection, however, at any rate has all the characteristics of a later appendage, and in language and spirit many of its hymns approach very nearly to the level of the contents of the *Atharvan*. Of the latter collection about one-sixth is found also in the *Rigveda*, and especially in the tenth book; the larger portion peculiar to it, though including no doubt some older pieces, appears to owe its origin to an age not long anterior to the composition of the *Brāhmanas*.

The state of religious thought among the ancient bards, as reflected in the hymns of the *Rigveda*, is that of a worship of the grand and striking phenomena of nature regarded in the light of personal conscious beings, endowed with a power beyond the control of man, though not insensible to his praises and actions. It is a nature-worship purer than that met with in any other polytheistic form of belief we are acquainted with,—a mythology still comparatively little affected by those systematizing tendencies which, in a less simple and primitive state of thought, lead to the construction of a well-ordered pantheon and a regular organization of divine government. To the mind of the early Vedic worshipper the various departments of the surrounding nature are not as yet clearly defined, and the functions which he assigns to their divine representatives continually flow into one another. Nor has he yet learned to care to determine the relative worth and position of the objects of his adoration; but the temporary influence of the phenomenon to which he addresses his praises bears too strongly upon his mind to allow him for the time to consider the claims of rival powers to which at other times he is wont to look up with equal feelings of awe and reverence. It is this immediateness of impulse under which the human mind in its infancy strives to give utterance to its emotions that imparts to many of its outpourings the ring of monotheistic fervour.

The generic name given to these impersonations, viz., *deva* ("the shining ones"), points to the conclusion, sufficiently justified by the nature of the more prominent objects of Vedic adoration as well as by common natural occurrences, that it was the beautiful phenomena of light which first and most powerfully swayed the Āryan mind. In the primitive worship of the manifold phenomena of nature it is not, of course, so much their physical aspect that impresses the human heart as the moral and intellectual forces which are supposed to move and animate them. The attributes and relations of some of the Vedic deities, in accordance with the nature of the objects they represent, partake in a high degree of this spiritual element; but it is not improbable that in an earlier phase of Āryan worship the religious conceptions were pervaded by it to a still greater and more general extent, and that the Vedic belief, though retaining many of the primitive features, has on the whole assumed a more sensuous and anthropomorphic character. This latter element is especially predominant in the attributes and imagery applied by the Vedic poets to *Indra*, the god of the atmospheric region, the favourite figure in their pantheon. While the representatives of the prominent departments of nature appear to the Vedic bard as consisting in a state of independence of one another, their relation to the mortal worshipper being the chief subject of his anxiety, a simple method of classification was already resorted to at an early time, consisting in a triple division of the deities into gods residing in the sky, in the air, and on earth. It is not, however, until a later stage,—the first clear indication being conveyed in a passage of the tenth book of the *Rigveda*, that this attempt at a polytheistic system is followed up by the promotion of one particular god to the dignity of chief guardian for each of these three regions. On the other hand, a tendency is clearly traceable in some of the hymns towards identifying gods whose functions present a certain degree of similarity of nature; these attempts would seem to show a certain advance of religious reflection, the first steps from polytheism towards a comprehension of the unity of divine essence. Another feature of the old Vedic worship tended to a similar result. The great problems of the origin and existence of man and universe had early begun to engage the Hindū mind; and in celebrating the praises of the gods the poet was frequently led by his religious, and not wholly disinterested, zeal to attribute to them cosmical functions of the very highest order. At a later stage of thought, chiefly exhibited in the tenth book of the *Rigveda* and the *Atharvaveda*, inquiring sages could not but perceive the inconsistency of such concessions of a supremacy among the divine rulers, and tried to solve the problem by conceptions of an independent power, endowed with all the attributes of a supreme deity, the creator of the universe, including the gods of the pantheon. The names under which this monotheistic idea is put forth are mostly of an attributive character, and indeed some of them, such as *Prajāpati* ("lord of creatures"), *Viśvakarman* ("all-doer"), occur in the earlier hymns as mere epithets of particular gods. But to other minds this theory of a personal creator left many difficulties unsolved. They saw, as the poets of old had seen, that everything around them, that man himself, was directed by some inward agent; and it needed but one step to perceive the essential sameness of these spiritual units, and to recognize their being but so many individual manifestations of one universal principle. Thus a pantheistic conception was arrived at, put forth under various names, such as *Purusha* ("soul"), *Kāma* ("desire"), *Bráhman* (neutr.; nom. sing. *bráhma*) ("devotion, prayer"). Metaphysical and theosophic speculations were thus fast undermining the simple belief in the old gods, until, at the time of the composition of the *Brāhmanas* and *Upanishads*, we find them in complete possession of the minds of the theologians. Whilst the theories crudely suggested in the later hymns are now further matured and elaborated, the tendency towards catholicity of formula favours the combination of the conflicting monotheistic and pantheistic conceptions; this compromise, which makes *Prājapati*, the personal creator of the world, the manifestation of the impersonal *Bráhma*, the universal self-existent soul, leads to the composite pantheistic system which forms the characteristic dogma of the Brāhmanical period.

The spirit of Vedic worship is pervaded by a strong belief in the efficacy of invocation and sacrificial offering. The earnest and well-expressed prayer cannot fail to draw the divine power to the worshipper and make it yield to his supplication; and offerings, so far from being mere acts of devotion which give pleasure to the god, represent the very food and drink which render him vigorous and capable of battling with the enemies of his mortal friend. This intrinsic power of invocation found an early expression in the term *bráhma* (neuter) ("religious devotion, prayer, hymn"); and its independent existence as an active moral principle in shaping the destinies of man became recognized in the Vedic pantheon in the conception of a god, *Brihaspati* or *Brahmanaspati* ("lord of prayer"), the guardian of the pious worshipper. This feature in the Hindū belief could scarcely fail early to engender and foster in the minds of the people feelings of esteem and reverence towards those who possessed the inspired gift of poetical expression, as

well as those who had acquired an intimate knowledge of the various forms of ritual worship. The common term used in the Veda for the officiating priest is *brahmán* (masc.; nom. sing. *brahmā*), originally denoting, it would seem, "one who prays, a worshipper," or "the composer or reciter of a hymn (*bráhman*, n.)" In some passages the word also signifies a special class of priests who officiated as superintendents during sacrificial ceremonies, the complicated nature of which required the co-operation of several priests. It is probable that in most cases the function of the poet or composer of hymns was combined with that of a minister of worship. In the Vedic hymns two classes of society, the royal (or military) and the priestly classes, were evidently recognized as being raised above the level of the *Viś*, or bulk of the Āryan community. These social grades seem to have been in existence even before the separation of the two Asiatic branches of the Indo-European race, the Āryans of Iran and India. It is true that, although the *Athrava*, *Rathaēstāo*, and *Vāstrya* of the *Zend Avesta* correspond in position and occupation to the *Brāhman*, *Rājan*, and *Viś* of the Veda, there is no similarity of names between them; but this fact only shows that the common vocabulary had not yet definitely fixed on any specific names for these classes. Even in the Veda their nomenclature is by no means limited to a single designation for each of them. Moreover, *Atharvan* occurs not infrequently in the hymns as the personification of the priestly profession, as the proto-priest who is supposed to have obtained fire from heaven and to have instituted the rite of sacrifice; and although *ratheshtha* ("standing on a car") is not actually found in connection with the *Rājan*

contact between the two races. What more natural, therefore, than that measures should have been early devised to limit the intercourse between them within as narrow bounds as possible. In course of time the difference of vocation, and the greater or less exposure to the scorching influence of the tropical sky, added, no doubt, to a certain admixture of Śūdra blood, especially in the case of the common people, seem to have produced also in the Āryan population different shades of complexion, which greatly favoured a tendency to rigid class-restrictions originally awakened and continually fed by the lot of the servile race. Meanwhile the power of the sacerdotal order having been gradually enlarged in proportion to the development of the minutiæ of sacrificial ceremonial and the increase of sacred lore, they began to lay claim to supreme authority in regulating and controlling the religious and social life of the people. The author of the so-called *Purusha-sūkta*, or hymn to Purusha, above referred to, represents the four castes—the *Brāhmanas*, *Kshatriyas*, *Vaiśyas*, and *Śūdras*—as having severally sprung from the mouth, the arms, the thighs, and the feet of Purusha, a primary being, here assumed to be the source of the universe. It is very doubtful, however, whether at the time when this hymn was composed the relative position of the two upper castes could already have been settled in so decided a way as this theory might lead us to suppose. There is, on the contrary, reason to believe that some time had yet to elapse, marked by fierce and bloody struggles for supremacy, of which only imperfect ideas can be formed from the legendary and biassed accounts of later generations, before the Kshatriyas finally submitted to the full measure of priestly pretension

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to each of them. These laws are conceived with no humane or sentimental scruples on the part of their authors. On the contrary, the offences committed by Brāhmans against other castes are treated with remarkable clemency, whilst the punishments inflicted for trespasses on the rights of higher classes are the more severe and inhuman the lower the offender stands in the social scale. The three first castes, however unequal to each other in privilege and social standing, are yet united by a common bond of sacramental rites (*sanskāras*), traditionally connected from ancient times with certain incidents and stages in the life of the Āryan Hindū, as conception, birth, name-giving, the first taking out of the child to see the sun, the first feeding with boiled rice, the rites of tonsure and hair cutting, the youth's investiture with the sacrificial thread, and his return home on completing his studies, marriage, funeral, &c. The modes of observing these family rites are laid down in a class of writings called *Grihya-sūtras*, or domestic rules. The most important of these observances is the *upanayana*, or rite of conducting the boy to a spiritual teacher. Connected with this act is the investiture with the sacred cord, ordinarily worn over the left shoulder and under the right arm, and varying in material according to the class of the wearer. This ceremony being the preliminary act to the youth's initiation into the study of the Veda, the management of the consecrated fire and the knowledge of the rites of purification, including the *sāvitrī*, a solemn invocation to *savitri*, the sun, which has to be repeated every morning and evening before the rise and after the setting of that luminary, is supposed to constitute the second or spiritual birth of the Ārya. It is from their participation in this rite that the three upper classes are called the twice-born. The ceremony is enjoined to take place some time between the eighth and sixteenth year of age in the case of a Brāhman, between the eleventh and twenty-second year of a Kshatriya, and between the twelfth and twenty-fourth year of a Vaiśya. He who has not been invested with the mark of his class within this time is for ever excluded from uttering the sacred *sāvitrī* and becomes an outcast, unless he is absolved from his sin by a council of Brāhmans, and after due performance of a purificatory rite resumes the badge of his caste. With one not duly initiated no righteous man is allowed to associate or to enter into connections of affinity. The duty of the Śūdra is to serve the twice-born classes, and above all the Brāhmans. He is excluded from all sacred knowledge, and if he performs sacrificial ceremonies he must do so without using holy mantras. No Brāhman must recite a Vedic text where a man of the servile caste might overhear him, nor must he even teach him the laws of expiating sin. The occupations of the Vaiśya are those connected with trade, the cultivation of the land and the breeding of cattle; while those of a Kshatriya consist in ruling and defending the people, administering justice, and the duties of military profession generally. Both share with the Brāhman the privilege of reading the Veda, but only so far as it is taught and explained to them by their spiritual preceptor. To the Brāhman belongs the right of teaching and expounding the sacred texts, and also that of interpreting and determining of so stringent a nature as to wholly repress it. To marry a woman of a higher caste, and especially of a caste not immediately above one's own, is, however, decidedly prohibited, the offspring resulting from such a union being excluded from the performance of the srāddha or obsequies to the ancestors, and thereby rendered incapable of inheriting any portion of the parents' property. On the other hand, men are at liberty, according to the rules of Manu, to marry a girl of any or each of the castes below their own, provided they have besides a wife belonging to their own class, for only such a one should perform the duties of personal attendance and religious observance devolving upon a married woman. As regards the children born from unequal marriages of this description, they have the rights and duties of the twice-born, if their mother belong to a twice-born caste, otherwise they, like the offspring of the former class of intermarriages, share the lot of the Śūdras, and are excluded from the investiture and the sāvitrī. For this last reason the marriage of a twice born man with a Śūdra woman is altogether discountenanced by some of the later law books. At the time of the code of Manu the intermixture of the classes had already produced a considerable number of intermediate or mixed castes, which were carefully catalogued, and each of which had a specific occupation assigned to it as its hereditary profession. The self-exaltation of the first class was not, it would seem, altogether due to priestly arrogance and ambition; but, like a prominent feature of the post-Vedic belief, the transmigration of souls, it was, if not the necessary, yet at least a natural consequence of the pantheistic doctrine. To the Brāhmanical speculator who saw in the numberless individual existences of animate nature but so many manifestations of the one eternal soul, to union with which they were all bound to tend as their final goal of supreme bliss, the greater or less imperfection of the material forms in which they were embodied naturally presented a continuous scale of spiritual units from the lowest degradation up to the absolute purity and perfection of the supreme spirit. To prevent one's sinking yet lower, and by degrees to raise one's self in this universal gradation, or, if possible, to attain the ultimate goal immediately from any state of corporeal existence, there was but one way,—subjection of the senses, purity of life, and knowledge of the deity. "He" (thus ends the code of Manu) "who in his own soul perceives the supreme soul in all beings and acquires equanimity toward them all, attains the highest state of bliss." Was it not natural then that the men who, if true to their sacred duties, were habitually engaged in what was most conducive to these spiritual attainments, that the Brāhmanical class early learnt to look upon themselves, even as a matter of faith, as being foremost among the human species in this universal race for final beatitude? The life marked out for them by that stern theory of class duties which they themselves had worked out, and which, no doubt, must have been practised in early times at least in some degree, was by no means one of ease and amenity. It was, on the contrary, singularly calculated to promote that complete mortification of the instincts of animal nature which they considered as indispensable to the final deliverance from the revolution of bodily and personal existence.

The pious Brāhman, longing to attain the *summum bonum* on the dissolution of his frail body, was enjoined to pass through a succession of four orders or stages of life, viz., those of *brahmachārin*, or religious student; *grihastha* (or *grihamedhin*), or householder; *vanavāsin* (or *vānaprastha*), or anchorite; and *sannyāsin* (or *bhikshu*), or religious mendicant. Theoretically this course of life was open and even recommended to every twice-born man, his distinctive class-occupations being in that case restricted to the second station, or that of married life. Practically, however, those

to a lonely wood, taking with him his sacred fires and the implements required for the daily and periodical offerings. Clad in a deer's skin, in a single piece of cloth, or in a bark garment, with his hair and nails uncut, the hermit is to subsist exclusively on food growing wild in the forest, such as roots, fruit, green herbs, and wild rice and grain. He must not accept gifts from any one, except of what may be absolutely necessary to maintain him; but with his own little hoard he should, on the contrary, honour, to the best of his ability, those who visit his hermitage. His time must be spent in reading the metaphysical treatises of the Veda, in making oblations, and in undergoing various kinds of privation and austerities, with a view to mortifying his passions and producing in his mind an entire indifference to worldly objects. Having by these means succeeded in overcoming all sensual affections and desires, and in acquiring perfect equanimity towards everything around him, the hermit has fitted himself for the final and most exalted order, that of devotee or religious mendicant. As such he has no further need of either mortifications or religious observances; but "with the sacrificial fires reposited in his mind," he may devote the remainder of his days to meditating on the divinity. Taking up his abode at the foot of a tree in total solitude, "with no companion but his own soul," clad in a coarse garment, he should carefully avoid injuring any creature or giving offence to any human being that may happen to come near him. Once a day, in the evening, "when the charcoal fire is extinguished and the smoke no longer issues from the fireplaces, when the pestle is at rest, when the people have taken their meals and the dishes are removed," he should go near the habitations of men, in order to beg what little food may suffice to sustain his feeble frame. Ever pure of mind he should thus bide his time, "as a servant expects his wages," wishing neither for death nor for life, until at last his soul is freed from its fetters and absorbed in the eternal spirit, the impersonal self-existent Brahmă.

The neuter term *bráhmă* is met with in the *Rigveda* both in the abstract sense of "devotion, worship," and in the concrete one of "prayer, hymn." Closely connected with it is found the masculine term *brahmá*, "a worshipper, a priest." The popular belief in the efficacy of invocation constituted a prominent feature of the Vedic symbolism, which the traditional and professional activity of the poet and minister of worship did, no doubt, much to keep up and foster. In the theosophical speculations of the later Vedic poets this mystic power of devotion found its fullest expression in the recognition of the *bráhmă* as the highest cosmical principle, and its identification with the pantheistic conception of an all pervading self-existent essence, the primary source of the universe. Whether this identification was originally due to some extent to the influence of class-interest possibly aided by the coincidence of name, or whether it was solely the product of a highly-wrought religious imagination, it is difficult to decide. Certain it is, however, that the term *bráhmă* began to be used about the same time as the abstract designation of priestly function and the Brāhmanical order in general, in the same way as the word *kshatra* came to denote the aggregate of functions and individuals of the military class

The tendency towards a comprehension of the unity of divine essence had resulted in some minds, as has been remarked before, in a kind of monotheistic notion of the origin of the universe. In the literature of the Brāhmana period we meet with this conception as a common element of speculation; and so far from its being considered incompatible with the existence of a universal spirit, *Prajāpati*, the personal creator of the world, is generally allowed a prominent place in the pantheistic theories. Yet the state of theological speculation, reflected in these writings, is one of transition. The general drift of thought is essentially pantheistic, but it is far from being reduced to a regular system, and the ancient form of belief still enters largely into it. The attributes of Prajāpati, in the same way, have in them elements of a purely polytheistic nature, and some of the attempts at reconciling this new-fangled deity with the traditional belief are somewhat awkward. An ancient classification of the gods represented them as being thirty-three in number, eleven in each of the three worlds or regions of nature. These regions being associated each with the name of one principal deity, this division gave rise at a later time to the notion of a kind of triple divine government, consisting of *Agni* (fire), *Indra* (sky) or *Vāyu* (wind), and *Sūrya* (sun), as presiding respectively over the gods on earth, in the atmosphere, and in the sky. Of this Vedic triad mention is frequently made in the Brāhmana writings. On the other hand the term *prajāpati* (lord of creatures), which in the *Rigveda* occurs as an epithet of the sun, is also once in the *Atharvaveda* applied jointly to Indra and Agni. In the Brāhmanas Prajāpati is several times mentioned as the thirty-fourth god; whilst in one passage he is called the fourth god, and made to rule over the three worlds. More frequently, however, the writings of this period represent him as the maker of the world and the father or creator of the gods. It is clear from this discordance of opinion on so important a point of doctrine, that at this time no authoritative system of belief had been agreed upon by the theologians. Yet there are unmistakable signs of a strong tendency towards constructing one, and it is possible that in yielding to it the Brāhmans may have been partly prompted by political considerations. The definite settlement of the caste system and the Brāhmanical supremacy must probably be assigned to somewhere about the close of the Brāhmana period. Division in their own ranks was hardly favourable to the aspirations of the priests at such a time; and the want of a distinct formula of belief adapted to the general drift of theological speculation, to which they could all rally, was probably felt the more acutely, the more determined a resistance the military class was likely to oppose to their claims. Side by side with the conception of the Bráhmă, the universal spiritual principle, with which speculative thought had already become deeply imbued, the notion of a supreme personal being, the author of the material creation, had come to be considered by many as a necessary complement of the pantheistic doctrine. But, owing perhaps to his polytheistic associations and the attributive nature of his name, the person of Prajāpati seems to have been thought but insufficiently adapted to represent this abstract idea. The expedient resorted to for solving the difficulty was as ingenious as it was characteristic of the Brāhmanical aspirations. In the same way as the abstract denomination of sacerdotalism, the neuter *bráhmă*, had come to express the divine essence, so the old designation of the individual priest, the masculine term *brahmá*, was raised to denote the supreme personal deity which was to take the place and attributes of the Prajāpati of the Brāhmanas and Upanishads. By this means the very name of the god expressed the essential oneness of his nature with that of the divine spirit as whose manifestation he was to be considered. Even in the later Vedic writings Brahmā is but rarely mentioned; and in some of these passages he is expressly identified with Prajāpati. It is in the institutes of Manu, where, as we have seen, the system of castes is propounded in its complete development, that his definite place is assigned to him in the cosmogony. According to this work, the universe, before undiscerned, was made discernible in the beginning by the sole, self-existent spirit (*brahmă*). He, then, having willed to produce from his own substance various creatures, created the

heavens. The modern god is represented as undergoing, for the benefit of mankind, a number of *avatāras* or incarnations, ten of which are especially dwelt upon by the fervid imagination of his followers. The exact time at which these several episodes were incorporated into the cult of Vishnu cannot at present be ascertained. As they are for the most part conceived in a decidedly Brāhmanical spirit,—the special object for which Vishnu assumes a human form being generally to deliver the people from the oppression of some wicked tyrannous prince,—it is probable that they were mostly introduced at a time when there was still some danger of the Kshatriyas defying the Brāhmanical rule. Of somewhat different origin were, perhaps, two of Vishnu's most popular and important incarnations, viz., those in which he manifests himself in the persons of *Krishna* and *Rāma*, two heroes whose exploits are celebrated in the Mahābhārata and Rāmāyana. It is possible that these warriors and their legendary achievements had been favourite subjects of heroic poetry for some time previous to the overthrow of the Kshatriyas, and that, being already regarded by the latter as representatives of Vishnu, they were afterwards recognized as such by the Brāhmans, and thus gave rise to the system of Avatāras.

The male nature of the triad was supposed to require to be supplemented by each of the three gods being associated with a female energy (*Śakti*). Thus *Vāch* or *Sarasvatī*, the goddess of speech and learning, came to be regarded as the *śakti*, or consort of Brahmā; *Śrī* or *Lakshmī*, "beauty, fortune," as that of Vishnu; and *Umā* or *Pārvatī*, the daughter of *Himavat*, the god of the Himālaya mountain, as that of Śiva. On the other hand, it is not improbable that *Pārvatī*,—who has a variety of other names, such as *Kālī* ("the black one"), *Durgā* ("the inaccessible, terrible one"), *Mahā-devī* ("the great goddess"),—enjoyed already a somewhat extensive worship of her own, and that there may thus have been good reason for assigning to her a prominent place in the Brāhmanical system. In later times a special sect, that of the *Śāktas*, or followers of any one of the *śaktis*, was principally devoted to her service; and up to our own days an almost national festival, the *Durgāpūjā* or *Daśarā*, accompanied by sanguinary sacrifices, is annually, in September or October, celebrated in her honour in Northern and Western India.

A compromise was thus effected between the esoteric doctrine of the metaphysician and some of the most prevalent forms of popular worship, resulting in what was henceforth to constitute the orthodox system of belief of the Brāhmanical community. Yet the Vedic pantheon could not be altogether discarded, forming part and parcel, as it did, of that sacred revelation (*śruti*), which it had been taught was the divine source of all religious and social law (*smriti*, "tradition"), and being, moreover, the foundation of the sacrificial ceremonial on which the priestly authority so largely depended. The existence of the old gods is therefore likewise recognized, but recognized in a very different way from that of the triple divinity. For while the triad represents the immediate manifestation of the eternal, infinite soul—while it constitutes, in fact, the Brahma itself in its active relation to mundane and seemingly material occurrences, the gods are of this world, are individual spirits or portions of the Brahma like men and other creatures, only higher in degree. To them an intermediate sphere, the heaven of Indra (the *svarloka* or *svarga*), is assigned to which man may raise himself by fulfilling the holy ordinances; but they are subject to the same laws of being; they, like men, are liable to be born again in some lower state, and therefore, like them, yearn for emancipation from the necessity of future individual existence. It is a sacred duty of man to worship these superior beings by invocations and sacrificial observances, as it is to honour the *pitris*, the spirits of the departed ancestors. The dead, on being judged by *Yama*, the Pluto of Hindū mythology, are supposed to be either passing through a term of enjoyment in a region midway between the earth and the heaven of the gods, or undergoing their measure of punishment in the nether world, situated somewhere in the southern region, before they return to the earth to animate new bodies. In Vedic mythology Yama was considered to have been the first mortal who died, and "espied the way to" the celestial abodes, and in virtue of precedence to have become the ruler of the departed; in some passages, however, he is already regarded as the god of death. Although the pantheistic system allowed only a subordinate rank to the old gods, and the actual religious belief of the people was probably but little affected by their existence, they continued to occupy an important place in the affections of the poet, and were still represented as exercising considerable influence on the destinies of man. The most prominent of them were regarded as the appointed *Lokapālas*, or guardians of the world; and as such they were made to preside over the four cardinal and (according to some authorities) the intermediate points of the compass. Thus *Indra*, the chief of the gods, was regarded as the regent of the East; *Agni*, the fire (*ignis*), was in the same way associated with the south-east; *Yama* with the south; *Sūrya*, the sun (Ἥλιος), with the south-west; *Varuna*, originally the representative of the all-embracing heaven (Οὐρανός) or atmosphere, now the god of the ocean, with the west; *Vāyu* (or *Pavana*) the wind, with the north-west; *Kubera*, the god of wealth, with the north; and *Soma* (or *Chandra*) with the north-east. In the institutes of Manu the *Lokapālas* are represented as standing in close relation to the ruling king, who is said to be composed of particles of these his tutelary deities. The retinue of Indra consists chiefly of the *Gandharvas* (etym. connected with κένταυρος), a class of genii, considered in the epics as the celestial musicians; and their wives, the *Apsaras*, lovely nymphs, who are frequently employed by the gods to make the pious devotee desist from carrying his austere practices to an extent that might render him dangerous to their power. *Narada*, an ancient sage, is considered as the messenger between the gods and men, and as having sprung from the forehead of Brahmā. The interesting office of the God of love is held by *Kāmadeva*, also called *Ananga*, the bodyless, because, as the myth relates, having once tried by the power of his mischievous arrow to make Śiva fall in love with Pārvatī, whilst he was engaged in devotional practices, the urchin was reduced to ashes by a glance of the angry god. Two other mythological figures of some importance are considered as sons of Śiva and Pārvatī, viz., *Kārttikeya* or *Skanda*, the leader of the heavenly armies, who was supposed to have been fostered by the six *Krittikās* or Pleiades; and *Ganeśa*, the elephant-headed god of wisdom, and at the same time the leader of the *dii minorum gentium*.

Orthodox Brāhmanical scholasticism makes the attainment of final emancipation (*mukti*, *moksha*) dependent on perfect knowledge of the divine essence. This knowledge can only be obtained by complete abstraction of the mind from external objects and intense meditation on the divinity, which again presupposes the total extinction of all sensual instincts by means of austere practices (*tapas*). The chosen few who succeed in gaining complete mastery over their senses and a full knowledge of the divine nature become absorbed into the universal soul immediately on the dissolution of the body. Those devotees, on the other hand, who have still a residuum, however slight, of ignorance and worldliness left in them at the time of their death, pass to the world of Brahmā, where their souls, invested with subtile corporeal frames, await their reunion with the

by far the largest share of adoration, and it is in special accounts of the *Śaiva*, *Vaishnava*, and *Śākta* sects rather than in an exposition of the Brāhmanical belief, that the religious history of India from about the beginning of our era can be dealt with satisfactorily. At that time the worship of Vishnu in his most popular avatār, in the person of *Krishna*, appears to have received much countenance at the hands of the priests, with a view of counteracting the growing influence of Buddhism. The sectarian spirit gave gradually rise to a special class of works, the modern *Purānas* composed for the express purpose of promoting the worship of some particular deity. In the 8th or 9th century *Śankara-āchārya*, a Malabar Brāhman of the Śaiva sect and Vedānta school of philosophy, made an attempt, by engaging in controversy with the leaders of various sects, to restore the Brāhmanical system of belief to its former imposing position. His example and teachings seem to have inspired the Brāhmanical community with a good deal of religious zeal, and even fanaticism, and thus to have greatly contributed to the final overthrow of the Buddhists. In the 7th century the authority of *Śākya-muni's* doctrine was already on the wane, as is evident from Hiouen Thsang's complaints of the number of ruined temples and deserted monasteries, and the great proportion of heretics. At the time of Śankara its decline must have been still more advanced, and a few more centuries probably sufficed to make the last living remains of the Buddhist faith disappear from the continent of India; except, indeed, in Nepal, where it prevails to this day. There also still exists in India a very important sect which seems to have early branched off from the Buddhist doctrine, viz., the *Jains*. Although, in the long run, Buddhism has been unable to maintain the ground it had won from the Brahmans, the humanizing spirit of its doctrines has left a deep impress on the Hindū mind. One of the practical and least salutary effects it has produced is the adoption of monastic institutions by most of the Brāhmanical sects. The *maths* or convents, in which a considerable portion of the clergy of the various religious bodies reside together, are presided over by *mahānts* or superiors, and are scattered all over India. Śankara founded several establishments of this kind in various parts, especially one still existing at Śringeri, on the Western Ghats. In spite of its levelling tendencies, Buddhism seems never to have succeeded in checking the further development of the caste system. At the time of Śankara seventy-two mixed classes, or eighteen subdivisions of each of the four original castes, are said to have existed, and ever since they have become more and more numerous. Indeed, there can be no doubt that Hindūs do not feel, and perhaps never felt, their class restrictions as being in any way burdensome, or still less a disgrace to them, and that even the lowest man looks upon his caste as a privilege as high as that of the Brāhman. In the opinion of the Brāhmans only one original caste is now extant, viz., their own, all the others having resulted from successive intermixtures.

Mr Sherring, in his *Hindu Tribes and Castes*, makes the following remarks on the Brāhmanical caste at the present day:—"The Brahman occupies the highest rank among Hindus for at least three reasons. The first is his assumed sanctity. By the people generally he is regarded as a pure, stainless, twice-born being, divine as well as human, worthy of unbounded admiration and worship. He is the priest of the Hindu religion, directing the ceremonies performed at the temples, sacred wells, sacred tanks, sacred rivers, and at all hallowed places throughout the land. He is present to sanction, and give effect to, the great social festivals of his countrymen held at marriages, at births of sons, and at deaths. He casts the horoscope, tells the lucky days, gives spiritual counsel, whispers *mantras* or mysterious words, executes magical incantations and charms, and is at once household god, family priest, and general preceptor and guide in behalf of the many millions of Hindus residing in the vast country lying between the Himalayas and Cape Comorin. The second reason of the Brahman's superiority is that, for many ages, perhaps from the outset of his career, when with other Aryans he first entered the plains of India, he has been intellectually in advance of the rest of the Hindu race. . . . The third reason is a consequent of the second. The Brahman is not only a thinking, but also a reading man. He possesses and, perhaps, reads the holy canon—Vedas, Shastras, and Purānas. He has been the author of Hindu literature. . . . Light of complexion, his forehead ample, his countenance of striking significance, his lips thin, and mouth expressive, his eyes quick and sharp, his fingers long, his carriage noble and almost sublime, the true Brahman, uncontaminated by European influence and manners, with his intense self-consciousness, with the proud conviction of superiority depicted in every muscle of his face, and manifest in every movement of his body, is a wonderful specimen of humanity walking on God's earth. Yet the Brahman has lived his day. His prestige is rapidly on the decline, and is only maintained at its ancient pitch in remote villages and in the fastnesses of superstition in great cities. Here, as of old, it envelopes him like a glory. But the further he moves from such places, the more dim becomes the glory until it fades away altogether. Education and other influences are treating the Brahman roughly. Yet the fault is his own. He has had a better start by reason of his great natural endowments than any Hindu of the other castes below him; but he has neglected his opportunities. I fear he has been too proud, too self-satisfied to avail himself of them."

On the modern observance of religious duties Professor Wilson remarks:—"Now it is true that in the present constitution of Indian society the distribution of the periods of life, beyond that of the student, is never regarded except by a few, who prefer a life of lazy mendicity, or by some half-crazed enthusiast, who thinks it possible to realize the letter of the law. The great body of the people, Brahmans included, pursue their worldly avocations as long as their faculties permit, spend the decline of life in the bosom of their families, and die peaceably and decently at home. But although the practice is discontinued, the doctrine remains and influences opinion; and devotional ceremonies, pilgrimage, penance, and abstract contemplation have an undue preponderance in the estimation of the people, even the best informed among them, over active duties and the precept of morality. As to the common people they have a still lower scale, and they find a ready substitute for the inconveniences of all moral restraint in the fervour of that faith which they place in Vishnu, and the unwearied perseverance with which they train a parrot or a starling to repeat his names, to articulate Krishna-Rādhā, or Sitā-Rām."

The study of the ancient literature of the Hindūs has taught us that some practices which have hitherto, or until recently, prevailed in India, and which have contributed so much to bringing Hindū morals into disrepute, are but comparatively modern innovations. Thus, the rite of *suttee* (properly *satī*, *i.e.*, "the faithful wife"), or voluntary immolation of widows, which was abolished some thirty years ago with considerable difficulty, seems to have sprung up originally as a local habit among the Kshatriyas, and, on becoming more and more prevalent, to have at length received Brāhmanical sanction. The alleged conformity of the rite to the Hindū scriptures has been shown to have rested chiefly on a misquotation, if not an intentional garbling, of a certain passage of the *Rigveda*, which, so far from authorizing the concremation of the widow, bids her

of bodies imparting the energy; (*b*) to measure directly the amount of frictional resistance between two bodies; or (*c*) to measure, indirectly, the amount of energy given out by the body or system of bodies producing it.

The first case is the familiar one occurring in the brakes of locomotives, railway carriages, and wheeled vehicles generally, and in those applied to such machines as cranes, winches, &c. Here some system of bodies,—or for simplicity's sake we may say some body,—originally at rest has been set in motion, and has received acceleration up to a certain velocity, the work which has been done in that acceleration being stored up as "actual energy" in the body itself. Before it can be brought to rest it must part with this energy, expending it in overcoming some external resistance. Very frequently the actual energy is very large in proportion to the usual resistance opposing the motion of the body, so that that motion would continue for a long time, or through a great distance, before the whole energy had been expended and the body brought to rest. For the sake of convenience, and in certain cases for the sake of safety, it is often necessary that this time or distance should be greatly shortened. This may be done by artificially increasing the resistance for the time being, and the most convenient method of doing this is the use of a brake.

The construction of railway brakes falls to be treated in detail in the article RAILWAYS. In other vehicles the brake belongs generally to one of two classes—it is either a block which can be pressed against a wheel by a suitable arrangement of levers under the control of the driver, or a slipper or "skid" which can be placed under a wheel, and which is attached by a chain or otherwise to the body of the vehicle. The increased resistance is due in the one case to the friction between the block and the wheel, and in the other to that between the skid and the road.

In the case of hoisting-machines the brake is used very frequently as a means of controlling the velocity of the descent of the load. In the process of "lowering by a brake," its frictional resistance is alone opposed to the load, and suitable mechanical means are provided for varying that resistance so that the velocity of the descending weight may be kept within the desired limits. The brake used in these machines very frequently consists of a cylindrical pulley or narrow drum encircled by a flexible belt of iron or steel. One end of this belt is fastened to the framing, and it is so formed that in ordinary work the drum revolves in it without touching it. When necessary, however, the position of the movable end can be so altered as to bring a larger or smaller area into contact, the surfaces being held together with a pressure which can be varied to suit the requirements of each case. This is effected either by a simple lever (in small machines worked by the foot), or for heavier work by the aid of a screw and hand-wheel.

In what are known as "differential" brakes the brake-band is not fixed to the frame of the machine, but both its ends are attached to points in a movable lever in such a way that motion of the lever affects them unequally, tightening one more than it loosens the other, or loosening one more than it tightens the other. The principle of such an arrangement is shown in fig. 1. Here A is the pulley, B the brake-band, and C the working lever; B being attached to the lateral points *a* and *b* unequally distant from the fulcrum D. It is obvious that for any motion of C the angular motions of the arms D*a* and D*b* are equal, but the instantaneous linear motions of the points *a* and *b* in the directions of the band are unequal, varying directly as D*a*, D*b*, the ratio of the normals from D upon those directions. Thus any motion of C to the right tends to tighten the lower part of the belt and to slacken the upper part, but the slackening takes place through a larger distance than the tightening, and the belt is therefore released from the drum. By moving the lever to the left, on the other hand, the opposite action occurs, and the belt is correspondingly tightened.

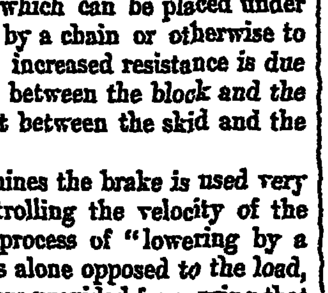


Fig. 1.—Differential Brake.

Instead of using the friction between two solid bodies, in some special cases the frictional resistance of a fluid is employed, as in what Professor Rankine called fan brakes and pump brakes. In the one case the motion of revolving blades (commonly) is opposed by the resistance of the atmospheric or liquid medium surrounding them, and in the other the motion of a liquid is opposed by the resistance due to a narrow passage or orifice.

The measurement of the frictional resistance between two bodies of known material or form is often of great importance, and it is still more often of importance to measure, by means of the frictional resistance which it can balance, the amount of energy given out by some engine or machine. Both these measurements can be and are frequently made by means of brakes. For this purpose the apparatus must be so made that the actual resistance can be accurately measured,—that this resistance can be kept sensibly constant for any length of time, but can be altered at will,—and also that the brake can be kept continuously at work for any desired period. The brake used for this purpose commonly takes the form of a revolving drum of iron, encircled by a ring of hard wood blocks connected together by thin iron bands. To this ring is attached a weight of known magnitude, at a known distance from the centre of the pulley. The wheel being set in motion the blocks can be gradually pressed upon it by a screw until the friction occurring is just sufficient to lift the weight and keep it off the ground or its support. So long as these conditions can be maintained the frictional resistance is exactly known, for its magnitude must be to that of the weight inversely as their distances from the centre of the wheel, and the energy expended in any given time will be equal to this resistance multiplied by the space passed through in the time by any point in the periphery of the drum.

Figs. 2 and 3 show the construction of a brake of this kind, copied from drawings kindly furnished by Mr W. H. Maw, the designer. The

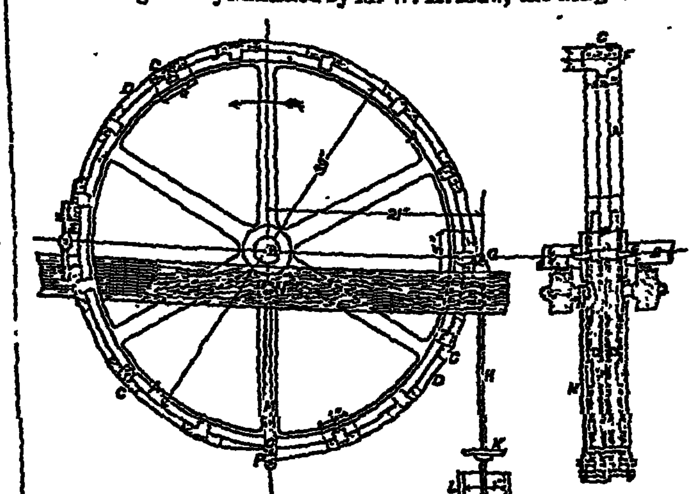


Fig. 2. Fig. 3.

FIGS. 2 and 3.—12 H.P. Friction Brake (designed by W. H. Maw).

drum A has a turned cylindrical surface 39 inches in diameter and 3½ inches wide; it is fixed upon the shaft B with which it revolves. The brake-ring consists of fourteen wooden blocks CC, connected

much altered by the architects engaged to carry on the work, and in particular by Michel Angelo. Competent judges are strongly of opinion that Bramante's designs, if carried out, would have had a much greater effect than those which were finally adopted.

Bramante had a great influence in Italy. By his careful study of the ancient forms of art he became the real introducer of the so-called classical style. His own genius was bold and inventive, delighting in mass and breadth, but occasionally failing in the perfection of detail.

BRAMANTINO. See SUARDI.

BRAMBÁNAN, a village in Java, notable for extensive and remarkable ruins of Hindu character. The place lies directly south of the great volcanic cone of Mir-Api (8640 feet) in the territory of the sultan of Yugya-karta (written by the Dutch Djokjo-karta), and 10 miles east of the capital, just on the border of the other native state called Surakarta or Solo.

The remains embrace six groups of temples, besides two buildings intended for residence, perhaps monastic. The most remarkable of the former is that called *Chandi Sewu*, or "The Thousand Pagodas." The centre of the group is a large temple of cruciform plan, standing on a terraced basement, and surrounded by four (originally, perhaps, by five) concentric squares, formed by rows of small detached cells or temples, the whole area forming a square of upwards of 500 feet to the side. Statements differ as to the exact number of these cells, but a plan given by Raffles shows 238 as now standing. They are sculptured externally with mythological reliefs, each is crowned with a small *dagoba* of the usual Buddhistic pattern (*i.e.*, very like the minor domes over the west portico of St Paul's), and probably all originally contained images of Buddha in the usual cross-legged attitude (of which a few still remain), whilst the central shrine contained, no doubt, a great image or images of Buddha also. Mr Fergusson thinks the group to be Jaina rather than Buddhist; and this a closer examination of the images and their symbols alone can decide. But similar series of shrines, clustered round a central pagoda, are found in Buddhist Pegu. There is a professed restoration of the central temple of Chandi Sewu in Raffles's *History*; but the details of this plate (pl. 40) are not to be relied on.

Another Buddhist edifice, single but more perfect, is known by the name of Chandi Kali Baneng. This also is cruciform; it stands on a boldly moulded basement, and the external decoration exhibits pilasters richly carved in scroll-work, and massive double cornices. Small Buddhas in niches remain, but the great figure which must have occupied the interior has disappeared.

A third group of temples, once, probably, the most important, is known as *Lara Jongran*. These are so ruined that at a short distance they present the aspect of vast and shapeless cairns of stone. One of them contains in three upper cells fine figures of purely Hindu and Brahmanical character. To the north is Durga (here in the character of a strong but beneficent power) slaying the demon Mahishásura,—precisely the same subject that is to be found in Moor's *Hindu Pantheon*, pl. 35. This is the *Lara* or Virgin, who gives the popular name to the group of temples. To the west is the elephant-headed Ganesha, and to the south a fine Jove-like Siva, bearded and trident-bearing. Offerings are sometimes made to these images by the peasantry, in spite of the universal Mahometan profession.

The name of the place is said by Friedrich to be properly *Parambánan*, and to mean probably "the Place of Teachers." The whole of the temples are alleged, in traditional rhymes, to have been erected between 1266 and 1296 A.D. But the chronology and history of the older Javanese remains is still very obscure, and probably the date of some of the Brambánan temples must be carried much farther back. The destruction of the last-described group must have been the work of earthquake, and we must suppose the date of the other buildings to be subsequent to the destruction. Some general points worthy of note in regard to these buildings are the following:—

(1.) They are all built of hewn stones without the use of any cement.

(2.) There are distinct traces showing that the exterior and interior of the buildings were once covered with a fine coat of stucco, not excepting the most elaborate sculpture in scroll-work, &c. We know that the sculptured cave-walls of Ellora, the great idols at Bamian, and the Doric order at Selinus were similarly coated; and probably in all these cases the stucco was intended to bear colour or gilding.

(3.) No real arch exists in these buildings. The vaults and doorways are covered by the corbelling, or stepped projection, of the horizontal courses. Mr Crawfurd makes a contrary statement, but that historian, usually so trustworthy, was certainly mistaken on this point.

(4.) Many of the peculiarities of this architecture, both in general plan and in ornamental details, indicate a close relation to the mediæval styles of Burmah and Camboja; and points almost necessarily to an original common type in India, a type which as yet we cannot trace satisfactorily. In this lies a problem of interest, which the accumulation of photographs will perhaps allow of being worked out. It is notable, however, that in the Burmese mediæval brick buildings of analogous character the true arch is used profusely.—(*Chiefly from the notes of a visit to Brambánan by the writer.*) (H. Y.)

BRANDE, WILLIAM THOMAS, chemist, was born at London in 1788. After leaving Westminster school he spent some time on the Continent, and acquired a knowledge of French and German. On his return he began the study of medicine, and in 1806 a communication of his to the Royal Society was printed in their *Transactions*. In 1809 he was made a fellow of the Royal Society, and became assistant to Sir Humphrey Davy at the Royal Institution. He succeeded Davy in the chair of chemistry in 1813, and in the same year received the Copley medal of the Royal Society. From 1816 to 1836 he was joint editor with Faraday of the *Quarterly Journal of Science and Art*. In 1825 he was made superintendent of the die department in the Mint, and in 1853 he received the honorary degree of D.C.L. of Oxford. He died on the 11th February 1866. Besides numerous papers, which marked him out as one of the most vigorous and able chemists of the day, Brande was the author of several important works. The *Manual of Chemistry*, 1819, and *Elements of Chemistry*, 1831, were the best works of the time, and soon became popular. He also published a *Dictionary of Materia Medica* in 1839, and a *Dictionary of Science, Literature, and Art* in 1842. The latter is an exceedingly able and valuable work of reference; a new edition of it has recently appeared under the editorship of Mr G. W. Cox, 1875. Brande was the author of the third of the Dissertations (that on the progress of Chemical philosophy) prefixed to the supplement of the fourth edition of the *Encyclopædia Britannica*.

BRANDENBURG, one of the largest provinces of Prussia, and the division from which that powerful monarchy originally sprung. It lies between 51° and 53° 34' N. lat. and 11° 25' and 16° 10' E. long., and is bounded on the N. by Mecklenburg and the province of Pomerania, E. by Posen and Silesia, S. by Silesia and the kingdom and province of Saxony, and W. by Anhalt and the provinces of Saxony and Hanover. It has an area of 15,403 square miles, and is divided into the two governments of Potsdam and Frankfort, the capital, Berlin, forming a separate jurisdiction. The province is a sandy plain, interspersed with numerous fertile districts and considerable stretches of woodland. Its barrenness was formerly much exaggerated, and it was popularly described as the sandbox of the Holy

It was translated into Latin in 1497 by Locher, and soon appeared in almost every European language. Alexander Barclay's *Ship of Fooles* (1509) is a free imitation of the German poem, and an abridged prose translation was published by Watson in 1517.

BRANDY, a spirituous liquor obtained by the distillation of wine, the aroma of which is due to ether and other volatile products. It may be distilled from any wine, but red wines yield a less pure and less aromatic spirit than light coloured varieties. In the departments of Charente and Charente Inférieure a variety of grape is cultivated exclusively for the production of brandy, the yield of which constitutes the cognac of commerce. In portions of the departments of the Landes, Gers, and Lot et Garonne, the preparation of brandy is also an important industry, and the produce is commercially known as armagnac, from the name of the district. The cognac district which produces the most rich and delicate spirit distilled is separated into distinct zones of production, according to the quality of the spirit each yields. In the centre of the district on the left bank of the Charente is the *Grande Champagne*, and radiating beyond it are the *Petite Champagne*, the *Premiers Bois*, and the *Seconds Bois* successively. The *Grande Champagne* is the source of the finest brandy anywhere produced; and as the area of cultivation recedes from that centre, the quality of the spirit proportionately lessens. The quantity of brandy exported in 1868 from Tonnay Charente was 9,187,416 gallons, valued at £1,887,678, the greater part of which was consigned to British ports; but the exports fluctuate greatly according to the character of the years. Thus in 1872 the total imports to Great Britain were only 3,505,295 gallons, while in 1873 the quantity was 6,483,486 gallons, of which 6,378,398 gallons came from France. By storage in oak casks the spirit takes up a portion of tannin, which gives it a delicate golden hue, but the deeper colour of brown brandy is communicated by caramel. Cognac is kept in carefully ventilated stores for two years, during which time it decreases in bulk and strength by evaporation, but mellows and develops aroma which continues to increase the longer it is kept. Brandy is very popular as a medicinal stimulant, and for use in cases of sickness, diarrhœa, and spasms. It is very often adulterated, and a vast amount of spirit which passes under the name is really either beetroot spirit or grain whisky coloured and aromatized with the cognac-flavoured œnanthic ether or Hungarian oil. See DISTILLATION.

BRANTFORD, a town of the Dominion of Canada, in the province of Ontario, capital of the county of Brant, is situated on the Grand River, about 24 miles south-west of Hamilton. It is an important station on the Goderich and Buffalo line, with extensive engine-works and foundries. Brass, iron, and tin wares, agricultural implements, window blinds, and pottery are its principal manufactures. It is lighted with gas, and has a good supply of water. As the river is not navigable as far as the town, a canal has been constructed which gives communication with Lake Erie. There are fine county buildings, ten churches, an orphanage, banks, and newspaper offices. Population in 1871, 8107.

BRANTÔME, PIERRE DE BOURDEILLES, SEIGNEUR DE, French historian and biographer, was born about 1540. He was the third son of the Viscount de Bourdeilles, and at an early age entered the profession of arms. He approved himself a brave soldier, and was brought into contact with most of the great leaders who were seeking fame or fortune in the wars that then distracted the Continent. Soon after the death of Charles IX. he retired from active life, and spent his last years in writing his *Memoirs* of the illustrious men and women whom he had known. He died on the 15th July 1614. He left distinct orders that his manuscript works should be printed, and a first edition appeared in 1665-6, not very complete. Of the later editions, the most valuable are—one in 15 volumes, 1740; another in 8 vols., 1787; one in 2 vols., 1842, by Buchon; that of the *Bibliothèque Elzévirienne* in 3 vols., 1858-9; and Lalanne's edition for the Société de l'Histoire de France, 6 vols., 1865, *seq.* Brantôme can hardly be regarded as a historian proper, and his *Memoirs* cannot be accepted as a very trustworthy source of information. But he writes in a quaint conversational way, pouring forth his thoughts, observations, or facts without order or system, and with the greatest frankness and naïveté. His works certainly gave an admirable picture of the general court-life of the time, with its unblushing and undisguised profligacy. There is not an *homme illustre* or a *dame galante* in all his gallery of portraits who is not stained with vice; and yet the whole is narrated with the most complete unconsciousness that there is anything objectionable in their conduct. There does not appear to be any English translation of Brantôme.

BRASIDAS, one of the most famous of the Spartan leaders in the early part of the Peloponnesian War, first distinguished himself by the relief of Methone, which was besieged by the Athenians (431 B.C.) For this service he was publicly commended at Sparta. In 429 he was sent to assist Cnemus, and appears to have taken part in the unsuccessful attack on the Piræeus. Two years later he accompanied the admiral Alcidas to Corcyra, but did not succeed in inducing his superior to make an attack on the city. He was severely wounded in the assault on Pylos (425), and lost his shield, which was picked up and carried in their triumph by the Athenians. When it was resolved by Sparta to carry the war into Thrace, Brasidas was selected as leader. He relieved Megara in 424, and in the same year succeeded in passing through Thessaly and in effecting a junction with Perdiccas of Macedon. He assisted Perdiccas to put down a revolted vassal, Arrhibæus, and then, in an extremely short time, partly by his skilful policy, partly by the rapidity and boldness of his movements, succeeded in gaining possession of Acanthus, Stagira, Amphipolis, and Torone. In the spring of 423 a truce was agreed upon; but Brasidas insisted upon retaining Scione, which had capitulated a day or two after the truce began; this was denied, however, by the Spartan general. The revolt of Mende gave him another opportunity, and he seized that town. Later in the same year he again accompanied Perdiccas against Arrhibæus, and made a most skilful retreat. He received no reinforcements from Sparta, where the leaders seemed jealous of his success, his conciliatory manners, and his dexterous policy. The Athenians, on the other hand, sent out a new armament, retook Mende, and repelled an assault on Potidæa. In 422 Cleon with the fresh Athenian troops besieged Amphipolis. A swift sally, directed by the skilful generalship of the Spartan leader, was crowned with success. The Athenians were routed, and Cleon slain, but Brasidas himself was mortally wounded. He was interred at Amphipolis, the inhabitants making him the founder of their city, and instituting yearly sacrifices and games to his memory. *Brasideia* were also celebrated to his honour in his native city, none but pure Spartans being allowed to join in the games. Brasidas is the only Spartan general whose character displays nobility or grandeur. He had to some extent thrown off the mental stiffness produced by the rigid oligarchical institutions of his native city. He could make himself popular with the allies, and the charm of his personal character secured for Lacedæmon many a city which would not otherwise have joined the league. Thucydides gives him great praise, describes him as being eloquent for a Spartan, and mentions his reputation for justice, liberality, and wisdom. Brasidas was indeed the

zinc, and as this alloy can be rolled out hot it is much more cheaply and expeditiously prepared than ordinary sheet brass.

Wire Drawing.—Brass wire is consumed in enormous quantities, first and chiefly for pin-making, next for shoe-rivets, then for brush-making, for paper-makers' wire web, and many other purposes. The metal for wire drawing is rolled into long strips of a suitable thickness and cut into "strands" by means of slitting rolls. The strands, which are square in section, are drawn through a succession of circular holes in a steel draw-plate, till the desired degree of fineness is reached, and are wound upon a rotating drum or block. The wire has to be repeatedly annealed as it passes through the plates of ever-diminishing gauge.

Stamping.—A large number of useful articles, as well as many ornamental details, which were formerly produced by the process of casting, are now cheaply and expeditiously made by stamping out of sheets of rolled brass. In this way the ornamentation applied to the cheaper kinds of gasaliers, balance-weights, chain-links, &c., are formed, and cornice-pole ornaments and curtain-rings made; and the process is also applied to the making of door and shutter knobs, finger plates, and lamp-burners, and to the striking up of many useful articles, such as basins and other vessels. In the process of stamping, a die, in which the pattern to be formed is sunk, is prepared by the ordinary process of die sinking, and securely fixed to a heavy iron block sunk into the ground. From each side of this block rise two cast-iron guide pillars, which act as guides to the heavy hammer or ram arranged to slide up and down between them. Into this hammer a "force," or exact counterpart of the sunk die, is fitted, so that on the fall of the hammer the force exactly fits into the die. The work of the stamper in raising his hammer is much lightened by passing the lifting belt over a pulley attached to a shaft moved by steam-power. By this arrangement the workman has only to hold his cord sufficiently tight to create the friction between the belt and pulley necessary to raise the weight, and by letting go his hold, the stamp is allowed to fall with its full momentum against the die. In a compound of such hardness and brittleness as brass it is necessary to raise any pattern by repeated strokes, annealing the metal between each separate blow. The number of blows necessary to bring up any pattern depends on the depth and convexity of the die. The "forces," or counterparts of the die, are made of lead, tin, or other soft metal, while for finishing the stamping when the die contains fine details a "force" made of brass is employed. A modification of the steam-hammer has been adapted for use in the process of stamping. Stamped work as compared with castings is deficient in depth and richness, as it is not practicable to attain any great boldness and sharpness of outline, and the "force" having to fit into every portion of the die, no undercutting is possible. Globular articles, such as balance weights, are stamped in two (or if necessary more) parts and the pieces joined by soldering. Mr James Atkins of Birmingham has patented an ingenious method of filling stamped shells, such as balance-weights, with molten iron by simply keeping the shell in water while it is being filled.

tied up with wire at short intervals to keep the edges together in the process of soldering; a mixture of granulated brass and borax is filled into the seam, and the tube is passed slowly through a strong heat in the soldering stove, which melts the granulated brass and so unites the edges. The wires are then cut away, and the superfluous solder filed off, the tube is pickled in sulphuric acid, and again passed through the steel conductor. In the case of tubes which require great accuracy of internal gauge, a mandril or solid cylinder of steel is placed inside the tube before it is finally passed through the tool. The external pressure causes the tube to fit closely to its internal support, and while the outside takes the outline of the steel conductor, the inside is made true to the shape of the mandril. Tubes of any given section are thus formed by the use of mandrils having the outline required. Ornamental patterns are impressed on plain tubes by fitting them on mandrils and passing them through a tool, which consists of a strong iron frame carrying three or more rollers so mounted that the open space between their external edges has the sectional form of the tube to be ornamented. On the external face of these rollers is sunk the design which is to be impressed on the tube, and as it is drawn through them the powerful squeeze they give is sufficient to impress ornaments of considerable depth and boldness. Cased-tubes or rods, that is, tubes or rods of iron cased in brass, were invented in 1803 by Sir Edward Thomason, who thus described his invention:—"In watching the operation of drawing brass and copper tubes upon the mandril, I found it required as much power to slide off the hollow tube from the mandril as was required to draw it on. Reasoning from the adhesion of the brass tube to the steel mandril, I found by experiment that the union of copper and iron or brass and iron could be firmly attached by pressure, and conceived that such an application would be useful for making copper bolts for shipping, solid brass rods for stair carpets, solid brass to go round the top of a room to suspend pictures, as curtain rods for drawing-rooms, and as balustrades for staircases." Wood is cased in brass by a similar process, and used for such purposes as brass cornice-poles. Solid or seamless brass tubes, which are in very extensive demand for locomotive and other steam boilers, are made by drawing down short thick cast cylinders of brass till they reach the desired gauge and thinness. The instrument in which this drawing is accomplished is similar to the apparatus for impressing ornamental patterns on plain brass tubes. Four steel rollers are mounted in a strong frame, the sectional outline of the outer surfaces of which have the size and form to which the tube is to be drawn, and through a series of such tools the cast cylinders are passed, after annealing at each operation. Mr G. F. Muntz in 1852 patented a method of drawing tubes cast in an oval form in the heated state.

Brass Finishing.—The operations in brass finishing comprise "dipping," "burnishing," and "lacquering," and in some cases brass-work is finished by "bronzing." After the article to be finished has been cleaned by pickling in acid, it is passed for dipping into an earthenware jar containing a solution of aquafortis (nitric acid). For bright dipping the acid is used strong, and the brass is immediately withdrawn from the bath, but for "dead" dipping, *i.e.*, for producing a bitten, frosted appearance, the bath is made weaker and the metal left in it till a creamy appearance is seen on the surface. Burnishing is accomplished by rubbing with polished steel tools, called burnishers, the parts of dead dipped work which are to be brightened. The work is then passed through water soured with acid, rinsed, and dried in boxwood sawdust. For lacquering, the work is heated over stoves, and while it is hot, a coating of varnish, made of seed-lac dissolved in spirit, is carefully

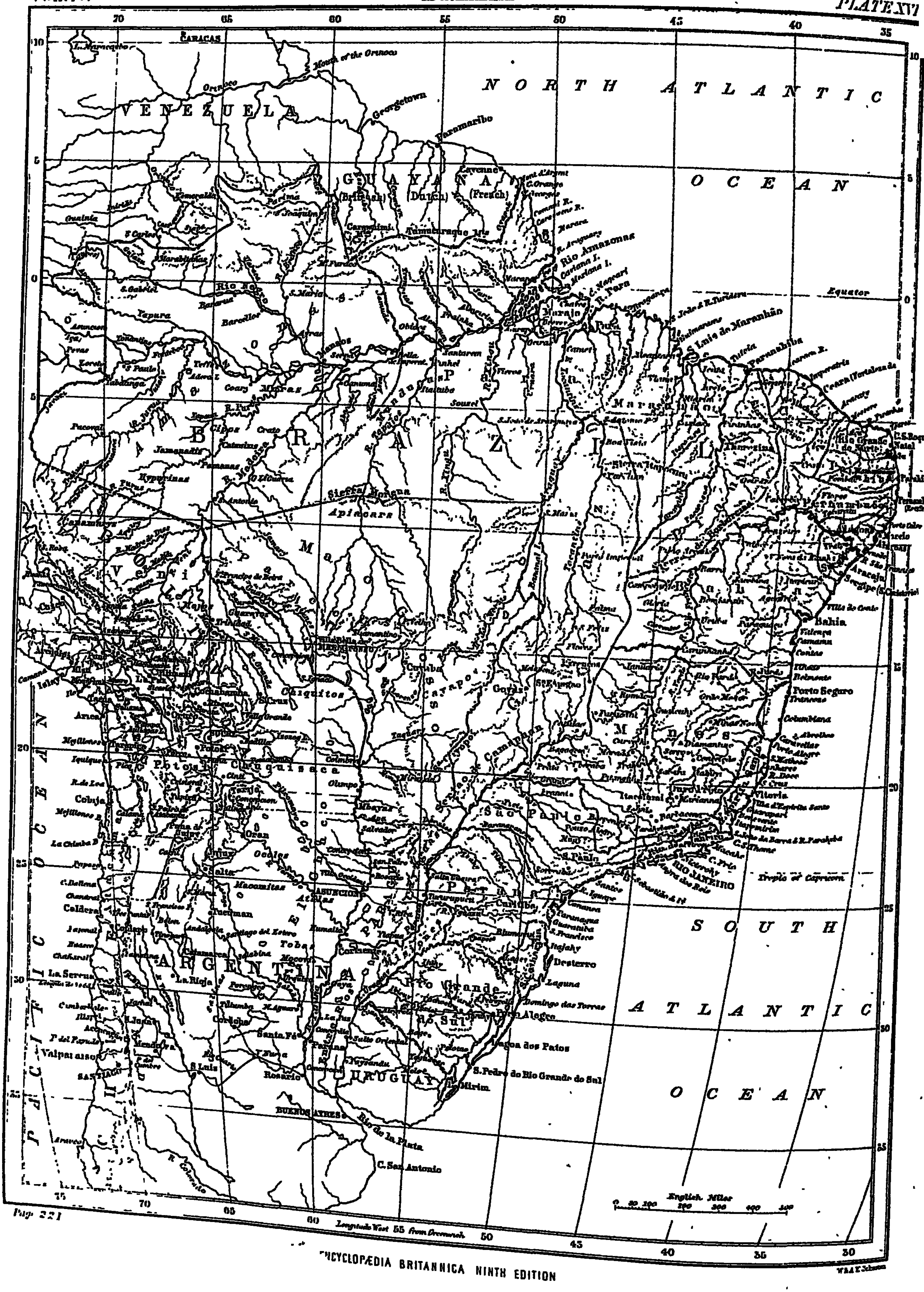
undertakings, was born at Baerton, near Chester, November 7, 1805. He was the son of a landed proprietor, of ancient family, and received an ordinary commercial education at a Chester school. He began his professional career at the age of sixteen as apprentice to Mr Lawton, a surveyor, and on the completion of his term became the partner of his master. Soon after his marriage his master died, and he assumed the sole management of the business. In the local surveys to which he devoted his attention during his early years he acquired the knowledge and practical experience which were the necessary foundation of his great reputation. His first engagement as railway contractor was entered upon in 1835, when, on the invitation of the distinguished engineer Joseph Locke, he undertook the execution of a portion of the Grand Junction Railway. Soon after Mr Locke entrusted him with the completion of the London and Southampton Railway, a task which involved contracts to the amount of £4,000,000 sterling and the employment of a body of 3000 men. At the same time he was engaged on portions of several other lines in the north of England and in Scotland. In conjunction with his partner, Mr W. Mackenzie, Brassey undertook, in 1840, the construction of the railway from Paris to Rouen, of which Mr Locke was engineer. He subsequently carried out the extension of the same line. A few years later he was engaged with his partner on five other French lines, and on his own account on the same number of lines in England, Wales, and Scotland. "At this time," says *The Builder*, "the industrial army set in motion and controlled by Mr Brassey amounted to 75,000 men, and his weekly payments must have distributed, as the price of labour, from £15,000 to £20,000 every Saturday. The capital involved in these various contracts amounted to some £36,000,000 sterling." But his energy and capacity were equal to still larger tasks. He undertook in 1851 other works in England and in Scotland; and in the following year he engaged in the construction of railways in Holland, Prussia, Spain, and Italy. One of his vastest undertakings was the Grand Trunk Railway of Canada, 1100 miles in length, with its astonishing bridge over the River St Lawrence. In this work he was associated with Peto and Betts. In the following years divisions of his industrial army were found in almost every country in Europe, in India, in Australia, and in South America. It must be remembered that, besides actual railway works, he originated and maintained a great number of subordinate assistant establishments, coal and iron-works, dockyards, &c., the direction of which alone would be sufficient to strain the energies of a common mind. His profits were, of course, enormous, but prosperity did not intoxicate him; and when heavy losses came, as sometimes they did, he took them bravely and quietly. Among the greatest of his pecuniary disasters were those caused by the fall of the great Barentin viaduct on the Rouen and Havre railway, and by the failure of Peto and Betts. Brassey was one of the first to aim at improving the relations between engineers and contractors, by setting himself against the corrupt practices which were common. He resolutely resisted the "scamping" of work and the bribery of inspectors, and effected what he called the "smothering of the engineer" by destroying the power of the inspectors and preventing all just grounds of dissatisfaction. Large hearted and generous to a rare degree, modest and simple in his taste and manners, he was conscious of his power as a leader in his calling, and knew how to use it wisely and for noble ends Honours came to him unsought. The cross of the Legion of Honour was conferred on him. From Victor Emmanuel he received the cross of the Order of St Maurice and St Lazarus; and from the emperor of Austria the decoration of the Iron Crown, which it is said had not before been given to a foreigner. He died at St Leonards at the age of 65, December 8, 1870. His life and labours are commemorated in a small volume published by Sir Arthur Helps in 1872.

BRAUNSBERG, a town of Prussia, capital of a circle in the government of Königsberg, on the Passaye, between three or four miles from its mouth in the Frische Haff. It is the seat of the Roman Catholic bishop of Ermeland, and possesses numerous Roman Catholic institutions. Of these the most important are the Lyceum Hosianum, founded in 1564 by the Cardinal Bishop Hosius, and in 1818 raised to the rank of a faculty of theology, and the deaf and dumb asylum which was established in 1811. There is also a school for the education of schoolmasters. Brewing, tanning, and weaving are the most important industries of the town, which also carries on a certain amount of trade in corn, ship timber, and yarn. The river is navigable for small vessels. Braunsberg was founded by the Teutonic knights in the middle of the 13th century. Destroyed by the Prussians in 1262 it was restored in 1279, and admitted to the Hanseatic League in 1284. After numerous vicissitudes it fell into the hands of the Poles in 1520, and in 1626 it was captured by Gustavus Adolphus. The Swedes kept possession till 1632. Population in 1871, 10,471.

BRAY, a seaport town and fashionable watering-place of Ireland, 12 miles S.S.E. of Dublin on the railway to Wexford. It is situated on both sides of the River Bray, which separates the two counties of Wicklow and Dublin, the portion in the latter county being known as Little Bray. The town is neatly built, and has a new parish church, a large Roman Catholic chapel, an old castle, a hospital, a court-house, several hotels, and Turkish baths. An esplanade runs along the shore for about a mile. The harbour admits small vessels only, and the trade is of little importance. There is a large brewery, which has been in existence for a considerable time. In the 12th century Bray was bestowed by Strongbow on Walter de Reddesford, who took the title of Baron of Bray, and built a castle in the town. It has since passed into the hands of various families. Its progress during the present century may be estimated by the gradual increase of the population—1841, 3185; 1851, 3156; 1861, 5363; 1871, 6077.

BRAY, Sir Reginald, architect, was the second son of Sir Richard Bray, one of the privy council of Henry VI. Having been instrumental in the advancement of Henry VII. to the throne of England, he was greatly in favour with that prince, who bestowed upon him honours and wealth. His taste and skill in architecture are attested by those two exquisite structures, Henry VII.'s chapel at Westminster and St George's chapel at Windsor. He directed the building of the former, and the finishing and decoration of the latter, to which, moreover, he was a liberal contributor. He died in 1503, and was interred in St George's chapel.

BRAY, Dr Thomas (1656-1730), was born at Marton, in Shropshire, and educated at Oxford. After leaving the university he was appointed vicar of Over-Whitacre, and rector of Sheldon. Bishop Compton sent him as his commissary to settle the affairs of the infant church of Maryland. He took a great interest in colonial missions, and busied himself in raising sums for purchasing small libraries for the use of missionaries; and to promote this design, he published his *Bibliotheca Parochialis*, and a discourse on *Apostolical Charity*. He endeavoured to establish a fund for the extension of the Christian faith, especially among the American Indians, and it is to his exertions that the Society for the Propagation of the Gospel owes its existence. He was the author of *Catechetical Lectures*, *Martyrology, or Papal Usurpation*, *Directorium Missionarium*, and other works.


NORTH ATLANTIC OCEAN
SOUTH ATLANTIC OCEAN
PACIFIC OCEAN
VENEZUELA
GUAYANA
(British)
(Dutch)
(French)
BRAZIL
ARGENTINA
URUGUAY
Caracas
Georgetown
Paramaribo
Cayenne
Rio Amazonas
Equator
Manaos
Santarem
Pará
S. Luiz de Maranhão
Parahiba
Ceara (Fortaleza)
Natal
C. S. Roque
Rio Grande do Norte
Pernambuco
Bahia
Porto Seguro
Rio Janeiro
C. Frio
S. Paulo
Curitiba
Desterro
Laguna
Porto Alegre
S. Pedro do Rio Grande do Sul
Lagoa dos Patos
Mirim
Rio Grande
Buenos Ayres
Rio de la Plata
C. San Antonio
Montevideo
Asuncion
Corrientes
Santa Fé
Rosario
Cordoba
Tucuman
Salta
Potosi
Chuquisaca
Cochabamba
Chiquitos
Cuyaba
Goyaz
Camapuan
Minas
Ouro Preto
Vitoria
Arica
Cobija
Iquique
Caldera
La Serena
Valparaiso
Santiago
Mendoza
S. Luis
S. Juan
La Rioja
Catamarca
Tropic of Capricorn
English Miles
Longitude West 55 from Greenwich

BRAZIL

ate VII. IN presenting an account of this extensive and important country, the only American monarchy we shall give, *first*, a condensed view of its physical geography, meteorology, and natural products; *secondly*, a brief historical sketch of the progressive discovery of its coasts and interior, of its gradual settlement, and of the auspices under which its social institutions have developed themselves; and *thirdly*, an account of its existing political and social condition.

ound-ies. Brazil is bounded on the N. by Columbia or New Granada, Venezuela, and the Guianas, British, French, and Dutch; on the E. by the Atlantic; on the S. by the republics of Uruguay and the Argentine Confederation; and on the W. by Paraguay, Bolivia, Peru, and Ecuador. It extends from about 4° N. lat. to 33° 41′ S. lat., and from 35° to 70° W. long. Its greatest length is about 2600 British miles, its greatest breadth about 2500; and it has a seaboard of about 4000 miles.

The original line of demarcation between the Portuguese and Spanish possessions was fixed by two bulls of Pope Alexander VI., the one of the 2d, the other of the 3d of May 1493. The kings of Castile and Portugal afterwards concluded the treaty of Torrizillas, which was approved by the Pope in 1529. The reunion of the two crowns in 1580 suspended all discussions about the boundaries. They, however, recommenced after the revolution and independence of Portugal. The treaty of Utrecht in 1777 regulated many points, but the treaties always referred to rivers, mountains, and other positions passing through deserts, the names of which were not well established. For sometime past the Government of Brazil has taken great pains to establish amicably with the neighbouring states the boundary lines of the empire. In 1851 these were established with the republic of Uruguay, in 1857 with the Argentine Republic, in 1858 with Peru, in 1859 with Venezuela, in 1867 with Bolivia, and in 1872 with Paraguay; the lines determined on have in some cases been already surveyed and marked out on the actual frontier, while at present mixed commissions from Brazil and each neighbouring country are employed in tracing out the other lines agreed upon.

With Uruguay the frontier has been marked out along a line passing from the coast in 33° 41′ S. lat., through the southern portion of Lake Mirim and along the River Jaguarão, which falls into it, to its most southerly source stream, thence by a line crossing the head of the Rio Negro to the dividing ridge called the Cuchilla Sta. Anna, and afterwards down the stream of the Cuarein or Quarahim to the River Uruguay.

The Uruguay River, from the mouth of the Quarahim upwards to the confluence of the Pepiry on its right bank in 27° 10′ lat. divides Brazil from the Argentine Republic, the remainder of the mutual frontier of these countries being formed by the Pepiry to its source and the São Antonio from its rise to its union with the Y-Guasú or Curityba, which river marks the boundary to the Paraná.

Between Paraguay and Brazil the frontier runs from the mouth of the Y-Guasú up the Alto Paraná to the great fall of Guayrá, called Sete Quedas by the Brazilians, and from that westward along the water-parting of the Cordillera of Maracajú, southward of the basin of the Igatimi, to the heights of Amambahý, and along these to the source of the Rio Apa-Estrella, following it down hence to the Paraguay.

With Bolivia the boundary lies along the Rio Paraguay from the mouth of the Apa in 22°, upwards to 20° 11′, where the Bahia Negra joins it; along the Bahia Negra, and thence in a line to the lake of Cáceres, cutting through the midst of this lagoon, and passing onward to Lakes Mandioré, Gaiba, and Uberaba, and from the last to the south end of the ridge called Corixa Grande; from this in a direct line to Morro de Buenavista (Boavista), and to the sources of the Rio Verde; along the middle of that stream to its mouth in the Guapore, and along that river and the Mamore to the Beni, where the Madeira begins in 10° 20′ S.; a direct line thence to the source of the Yavari River (found by Chandless in 1867 to be a little south of 7° S. lat.), forms the limit of Brazil with Northern Bolivia and Central Peru. The Yavari continues the boundary between Brazil and Peru down its channel to the confluence with the Amazon at Tabatinga, and the limits commission has been at work during 1874 and 1875 in determining the position of this line. Farther on, the boundary of Brazil with Northern Peru has been described as a line passing northward from Tabatinga towards the mouth of the Rio Apaporis in the River Japura, the frontier with Peru terminating on this line where it intersects the Rio Putumayo, and that with Ecuador beginning there. From the mouth of the Apaporis the continuation of the limit with Columbia or New Granada to that with Venezuela follows a line drawn along the water-parting of the range called the Collina do Guaicia or Serra Aracuara, which divides the streams flowing to the Guainia, or Rio Negro, above the Casiquiáre, from those which join it below the anastomosis of that natural canal. This line meets the Rio Negro about 20 miles below the separation of the Casiquiáre. From the Sierra Cucuhy, or Pão d'Azucar, on the opposite or left bank of the Rio Negro, the limit continues eastward over the level ground to the middle of the natural canal called the Maturacá, which in times of flood unites the Cababoris tributary of the Rio Negro with the Barria, a sub-tributary of the Casiquiáre channel. Hence the limit is drawn from the Maturacá to the hill of Cupi, the first of the long range of Serras which divide the waters flowing to the Amazon from those tributary to the Orinoco, and those passing through British, Dutch, and French Guiana to the Atlantic. This boundary follows the curves of the water-parting eastward along the Serras named Guahy and Ucuruciro; northward on those of Tapirapecó and Parima; eastward again along the Merevary and Pacaraima heights; southward between the rivers Tacutu and Rupununy, and again generally eastward along the Serras of Acarahy and Tucumuraque to the source of the River Oyapok. This river, from its source to the Atlantic in 4° 22′ N. lat., is the present eastward limit of French Guiana. Several islets in the Atlantic belong to Brazil; among them that of Fernando Noronha, 250 miles from Cape S. Roque, high, and having about 6 square miles of area, is important as a penal settlement of the empire.

The immense territory comprised within the line just described and the Atlantic is upwards of 3,288,000 English square miles in area, or not far short of the extent of Europe.

The great river of the lowlands of Brazil, the Amazon, Rivers. has been called the Mediterranean of South America, and is the largest stream of the globe in every respect, affording, with its great tributaries, free navigation over not less than 30,000 miles within Brazilian territory (see AMAZON).

After the Amazon the Tocantins is the great river of the northern watershed of Brazil. Rising in the Serra das Vertentes in Central Brazil, the Araguaya, its longer head stream, and the Tocantins flow northward for 900 miles, separated by the Cordillera Grande of Goyaz, and unite at about 300 miles from their wide estuary, called the Rio Pará, formed between the island of Marajo and the main-

land. Midway in its course the Araguaya forms the remarkable island called the Ilha Bananal or Santa Anna, which is encompassed by branches of the river 220 miles in length, and contains a central lake of 80 miles in extent. The Araguaya is navigable, but the upper Tocantins is barred by falls, and there is a rapid at some distance below their confluence round which a road has been recently made to unite the navigable portions.

The Turyassú, Maranhão, and Paranahyba are the largest of the other rivers of the north-eastern slope. The last named flows for the greater part of its course of 700 miles through level swampy lands, receiving many tributaries from eastward, but few from the west; it is without obstructions, and navigable for a great distance.

The São Francisco occupies a wide enclosed basin of the eastern highland. Rising in the Serra do Espinhaço and the Vertentes of Minas Geraes, it flows north and eastward in a course of 1800 miles. But for a few obstacles the greater part of the river would be navigable, since it has great volume. The chief barrier is in the Falls of Paulo Affonso, about 168 miles from the sea, where the river is contracted between rocks, and plunges in a series of cascades into a narrow rock-impeded channel. Immediately below this, however, it spreads out as a broad calm river, which is regularly navigated by steamers from the Porto das Piranhas to the sea.

Among the rivers of the coast slope south of the São Francisco the chief are the Paraguasú, the largest stream of the province of Bahia, obstructed by many falls; the Rio de Contas or Jussiapé, a considerable river in the south of the province, also innavigable; the Belmonte or Jequitinhonha from the high mountains of Minas Geraes, interrupted by many rapids and cascades, and forming a series of magnificent falls over the eastern edge of the plateau, in which it descends at least 300 feet; the Rio Doce or Chopotó in the province of Espiritu Santo, affording a considerable length of navigation, with portages at its reefs; and the Parahyba do Sul, flowing between the Serra da Mantiqueira and the coast range of Rio de Janeiro, navigated regularly by steamers from its mouth for 60 miles to São Fidelio. Though these coast streams are among the little rivers of Brazil, every one of them is two or three times the length of the Thames.

The great rivers of the southern watershed are the Paraná and Paraguay. The former has its rise in a broad basin, extending for a width of nearly 700 miles across southern Brazil, enclosed by the coast range of the south, the Serra da Mantiqueira, the Vertentes, and its southward interior branch running down into Paraguay. The main and longest head stream of the Paraná is called the Rio Grande or Pará, which rises in the Serra da Mantiqueira, one of its sources being on the slope of Itatiaiossú, the highest point of the whole empire, 110 miles north-west of Rio de Janeiro. The Paranahyba joins the Grande on the right from the Pireneos range in the north, and further on the Paraná-Panema, with its tributary the Tibagy, comes in on the left bank from the inner slopes of the south coast range; the Rio Pardo, Ivinhima, and Igatimi are smaller tributaries on the left bank from the interior ranges. After the confluence of the Grande and Paranahyba the Paraná takes its proper name and flows southward out of Brazil in forming the limit between the empire and the republic of Paraguay. The fall of Urubupunga, 40 miles below the confluence of the Grande and Paranahyba, is an obstacle to the navigation of the upper river; but thence to the great "salto" of Guayrá on the frontier of Paraguay, in 24° S., it is freely navigable. The fall of Guayrá, Sete-quedas, or Seven Falls, is the greatest cataract of Brazil. Immediately above it and below the large island which the Paraná forms between 23° and 24° the river is about 2½ miles in width; its channel is contracted first in passing through a diagonal line of seven islands which stretches across it, and then between the walls of a rocky gorge only 65 yards in breadth, into which the whole mass of water plunges with terrific fury, descending over a slope inclined about 50°, and for a perpendicular height of about 60 feet. The roaring of the cataract may be heard for many leagues round. Below the fall, the river rushes down in a narrow bed with high cliff-like banks, only becoming less rapid and navigable with difficulty as it leaves the Brazilian frontier at the confluence of the Y-Guasú. This tributary, also named the Curityba, has a westward course to the Paraná, from many heads in the inner side of the south coast range, and like all the tributaries of the Paraná between it and the great fall, descends into the deep gorge of the main river by a fine waterfall of 66 feet.

The River Paraguay, the upper basin of which lies in a much lower region of the continent, in the south-western interior of Brazil, is far superior to the Paraná in respect of its navigable qualities, and in the grand natural outlet it affords to the southward. Its sources are in several small lakes on the southern slope of the Serra das Vertentes, between 13° and 14° S., immediately opposite the head streams of the Tapajos, and it flows thence southward, fed by many lateral streams from the range. Its important tributary the Cuyabá, or São Lourenço, rises not far east of the Paraguay, but does not join it until both have passed about 400 miles south. The Taquari, the Mondego, and the Apa, the boundary river of Brazil and Paraguay, are important tributaries from the range which divides the basins of the Paraguay and Paraná; and from the hills of eastern Bolivia the San Juan and Bahia Negra join the Paraguay on the right bank. Throughout its course the Paraguay affords uninterrupted navigation, and is regularly traversed by large Brazilian steamers from the Rio de la Plata to Curumbá, in the province of Matto Grosso, a distance of about 1000 miles in a direct line from Buenos Ayres. Thence smaller vessels carry on a regular traffic for 300 miles further, by the São Lourenço tributary, to Cuyabá in the very heart of inner Brazil. An immense tract of the low country on each side of the upper Paraguay, called the Xarayes, between 17° and 19° lat., is subject to inundation in times of flood.

While the Amazon begins to rise in February or March, and is at its highest flood in June, the Paraná is irregular in its risings, but has its greatest volume in December, and the Paraguay again, regularly swelling and falling, is highest in June.

The surface of Brazil in respect to its elevation is divided into the *higher region* of plateaus, ridges, and broad open valleys, occupying the whole of the country south of the parallel of Cape S. Roque, and the vast *lowland plain* of the Amazon, extending inland to the base of the Andes of Peru, Equador, and Columbia, and rising again in the extreme north to the ranges which form the boundary with Venezuela and Guiana. Surface.

The nucleus of the mountains and plateaus of southern Brazil is not centrally placed, but is formed by the chains named the Serra da Mantiqueira and Serra do Espinhaço, which extend between 18° and 23° south lat., at a varying distance of from 100 to 200 miles from the south-east coast. These are the highest and most important mountains of Brazil, from which the other ranges and plateaus radiate outwards north, west, and south; one of the summits of the Serra da Mantiqueira is the Pico do Itatiaiossú, which is almost certainly the culminating point of Brazil, but the elevation of its peak has been very variously estimated and measured at from 6250 to 8900 and 10,300 feet. Itacolumi, near the town of Ouro Preto, reaching about 5700 feet, and Itambe in the north of the Serra do Espinhaço, 4300 Mountains and plateaus.

feet, are the other high points of these ranges. The southern coastal range, or the Serra do Mar, begins immediately north of the Bay of Rio de Janeiro, where the Orãgos or Organ Mountains, with sharp peaks, rise to perhaps 7500 feet, and follows the line of the shore southward at varying distances from it to near the 30th parallel. The line of the Serra do Espinhaço is prolonged northward by another maritime chain or plateau edge, more distant from the ocean, forming the eastern barrier of the great valley of the Rio São Francisco, and terminating where the river turns eastward to reach the sea.

A range of high plateaus, probably from 3000 to 4000 feet in general elevation, and named collectively the Serra das Vertentes, or the range of the watersheds, but bearing a multitude of different names in its local sections and branches, extends westward from the Serra do Espinhaço, nearly at right angles to its direction, traversing the entire country in curving lines inland for upwards of 2000 miles to where the plateaus of Brazil terminate on the great bend, and the cataracts, of the Rio Madeira. This very extensive range divides the waters flowing northward to the lower Amazon and to the Atlantic shores of the north-east, from those tributary to the great basins of the Paraguay and Paraná in the south. Its highest known portion is that called the Montes Pyreneos, between the heads of the Tocantins and Paranahyba in the province of Goyaz, one of the summits of which has been found to be perhaps 9600 feet above the sea (H. R. Dos Genettes, 1868). Long branches ramify northward and southward from the Vertentes; the principal of those trending northward is that which, leaving the main line of division at the Pyreneos, curves round the basin of the São Francisco, terminating in many minor branches on the coast on each side of Cape S. Roque. A lateral branch from this divides the streams of the Tocantins and of the northern Paranahyba. Farther west the Cordillera Grande of Goyaz runs north from the Vertentes, separating the Araguaya and Tocantins, and still more inland minor ranges mark out the basins of the Xingu and Tapajos. A southward arm of the Vertentes, or rather a series of plateaus extending from it, divide the Paraguay from the Alto Paraná, and run into Paraguay as the heights of Amambahý, which have an elevation of little over 2000 feet above the sea where they cross the frontier. These are the main lines of height, but over the whole of the plateau of Southern Brazil a great number of lesser ridges run out from these between each of the tributary river basins.

The extremely level character of the great northern lowlands may be judged of by this, that the banks of the Amazon where it enters Brazil at Tabatinga, more than 1500 miles in a direct line from the sea, are not more than 250 feet above the ocean level, and a continuous navigation is afforded by its tributary the Rio Negro, the Casiquiare, and the Orinoco, to the northern coast of the continent.

logy. The great constituent of all the mountain ranges of the southern highlands of Brazil appears to be gneiss, varying from schistose to coarse-grained and porphyritic, or homogeneous and granitic; and though much of it if seen in a small specimen would be and has been described as granite, the larger masses are always stratified. These rocks are of great thickness in the province of Rio, and the Serra do Mar and Serra da Mantiqueira are wholly composed of them; not only does gniess form the great coast belt from Maranhão to the mouth of the Rio de la Plata, but it sends off a band into Minas Geraes and Goyaz, where the Pyreneos range and a great part of the mountain region are composed of it. The same rock shows itself in the cataracts of the Tocantins, Xingu, Tapajos, and Madeira, as well as in the Parima Mountains north of the Amazon basin, showing that the high land of Brazil is probably everywhere underlaid by it. Clay-slates with auriferous veins occur in Minas Geraes and in the vicinity of Cuyabá in Matto Grosso, everywhere so metamorphosed that all trace of fossils has been obliterated. True Carboniferous strata occur in Brazil, the coal basins lying just south of the tropic, and being a coast-formation not known northward of Rio. Carboniferous rocks also occur on the Guapore, a tributary of the Madeira on the Bolivian frontier. Red sandstones occupy a large area in the province of Sergipe, underlying the Cretaceous formation. The Jurassic rocks, which extend on the Andes from Chili to Peru, appear to be altogether wanting in Brazil. Cretaceous rocks very probably underlie the great plain of the Amazon; they do not appear on the coast south of the Abrolhos rocks in 18° S., but they occur at intervals northward, and have been examined on an affluent of the River Purus in the upper basin of the Amazon. These appear to have been deposited at a period when the northern part of Brazil was more depressed, while the southern may have been higher than it is now. Tertiary clays and ferruginous sandstone, in horizontal and undisturbed beds, overlie the Cretaceous rocks unconformably on the coast plains outside the plateaus and in the São Francisco valley; the horizontal deposits of the plateau of São Paulo evidently belong to the same group.

Surface "drift" deposits, ascribed with the greater amount of probability to the agency of glacial ice, though the hypothesis has been much disputed, occur as a great sheet of pebbles and overlying clay, extending over an immense area of the empire,—over the whole of the provinces south of Rio, over Minas Geraes in the north-eastern coast provinces, and in the valley of the Amazon westward to the confines of Peru; and not only on the hills but over the lower "campos." Deposits of immense boulders of trap and gneiss, evidently the moraines of former local glaciers, were first described by Professor Agassiz, who found them at many points along the coast land.

True coral reefs occur at irregular intervals along the northern Brazilian coast from the Abrolhos islets, which rise on the submerged border of the continent from a less depth than 100 feet, as far as the shores of Maranhão. They lie in patches at short distances from the coast, leaving navigable channels between them and the mainland. Another class of reefs, also termed "recifes," but of totally different origin, are the consolidated stone beaches, such as those seen at Porto Seguro, Bahia, and Pernambuco (where the reef forms the breakwater of the harbour); these are of precisely uniform character, and have been described by Professor Hartt as the consolidated cores of an ancient beach which has been separated from the mainland by the encroachment of the sea. (*Geology and Physical Geography of Brazil*, by Ch. Fred. Hartt, 1870.) The limestones of the upper São Francisco basin have celebrated bone caverns, which have been made a special object of study by the Danish naturalist Lund. In some of these the remains of extinct animals of high antiquity have been found, such as those of the mastodon, glyptodon, mylodon, toxodon, and megatherium; and with these the stone implements and remains of man, so buried with the bones of the extinct fauna as to leave no doubt that man was contemporaneous with them.

No volcanic appearances have been observed in Brazil. Warm springs Warm springs occur in several provinces; those of Itapicurú in the province of Bahia have temperatures varying from 88° to 106° Fahr. and are saline; the hot springs of pure water in Santa Catharina range from 96° to 113° Fahr., and there are a great number of alkaline springs about the district of Santa Cruz, in the province of Goyaz, ranging up to 119° in temperature. Near the village of Caldas in Minas Geraes the hot wells are very voluminous, and their somewhat sulphurous waters have temperatures between

106° and 113° Fahr. These are at an elevation of about 6000 feet above the sea.

INERALS. The metallic and mineral products which occur in the geological formations above described are very various. iamonds. Diamonds were first discovered in the Serra do Espinhaço, in the vicinity of Diamantina, about 300 miles north of Rio, in 1786. In this neighbourhood there are shales, sandstones, and conglomerates; upon the sandstone there is or was a stratum of quartzite, still very distinct in many places, and among the sands created by the disintegration of this rock, diamonds are found. This district is named the *Chapada* of Diamantina, a term applied to small elevated plateaus, usually consisting of horizontal deposits, and separated by deeply eroded valleys. The diamond-producing soil extends along the Serra do Espinhaço as far as the northern borders of the province of Minas, along the valley of the upper Belmonte, and in the interior of the province of Bahia, as well as in the mountains that lie south-west of the sources of the São Francisco. Diamonds of smaller value have also been found in the province of Goyaz (on the Rio Claro); in Matto Grosso, where the valley of the Paraguay about Cuyabá and Diamantino has diamonds in considerable abundance; in Paraná, on the Rio Tibagy, a tributary of the Paraná-Panema; in São Pedro do Rio Grande do Sul; and in São Paulo;—but the area of their distribution is far from being well ascertained. The diamonds are generally obtained by washing; an excavation is made to reach the stratum called *cascalho*, a gravel composed principally of quartz and fragments of different rocks of the neighbourhood, and mixed with a reddish clay. The washers are seated either by a pond or running stream, and a portion of the gravel, being thrown into a large shallow wooden pan, is mixed with water and stirred about in the current, so that the muddy water escapes and the gravel and sand remain. This is now passed through a sieve, which separates the larger gravel from the smaller; the pebbles are then picked out, and the overseer examining the sand easily selects any diamonds that may be present. The diamonds are often of considerable size. Burton mentions one found in the Chapada of Bahia weighing 76½ carats, which when cut into a dropshaped brilliant proved to possess extraordinary play and lustre. Emeralds, sapphires, rubies, topazes, beryls, tourmalines (black, blue, or green), and amethysts are found, especially in the provinces of Minas Geraes. Garnets occur in great profusion, though of inferior quality. Rock crystals, perfectly pure and of large size, are obtained in Minas, Goyaz, São Paulo, and Paraná; opals, chalcedonies, agates, and carnelians are found nearly throughout the country, but have become an article of export chiefly from the banks of the Uruguay, in the province of Rio Grande do Sul.

One of the Brazilian coal basins lies in the province of Santa Catharina, between the plateau and the sea; and along the banks of the Tubarão, beds of bituminous coal of fair quality are exposed, and were first noticed in 1841. Three separate coal-fields have been traced in the province of Rio Grande do Sul: the largest is situated in the valley of the Jaguarão (the boundary river with Uruguay), and in that of the Candiota, covering an area of about 50 miles by 30 miles; the second occurs in the valley of a tributary of the Rio Jacuahy, near the centre of the province; and a third near the village of São Jeronymo, on the bank of the Jacuahy. The Candiota field is now being worked by an English company. At the Arroyo dos Ratos in the same province, mines have been worked on a small scale, the coal from which is used by the steam-boats which ply on the Lagoa dos Patos, or on the rivers. Bitumen is found in most of the provinces, and is worked near the south coast of the province of Bahia.

Sulphur exists in a native state in the province of Rio Grande do Norte, and in small quantity in Rio Grande do Sul, as well as at Furquim and Corrego do Ouro, in the district of Minas Novas in Minas Geraes. Saltpetre occurs with salt over a large area of Minas Geraes and Bahia, but is also abundantly formed in the floors of the calcareous caves of the Rio São Francisco valley from the city of Ouro Preto downwards. Saline efflorescence is observed at innumerable localities in the drier portions of the Brazilian plateau; efflorescences of nearly pure sulphate of magnesia are also to be found in the valley of the Rio das Velhas in the São Francisco basin, and in the province of Ceará, where chloride of sodium also appears. Saltpetre. Salt.

Gold in Brazil is found in quartz veins traversing the old metamorphic rocks, such as clay-slate, mica-slate, or iron schist, in drift gravels and clays, and in alluvial sands and gravels derived from the wear of these. Most gold is afforded by the clay-slates traversed by auriferous quartz lodes, by the rock called Itacolumite (metamorphic rock of Lower Silurian age), and by certain iron ores known as Itabirite and Jacutinga, the latter described by Burton as a substance composed of micaceous iron schist and friable quartz, mixed with specular iron oxide of manganese and fragments of talc. Over a very large area of the province of Minas Geraes, in the vicinity of Ouro Preto, the country is auriferous, and here are the richest gold mines of Brazil. The celebrated Morro Velho mine is situated on the western side of the valley of the Rio das Velhas, not far from Sabará, and was at first worked by native miners, but afterwards with great success by a company. The mines of Gongo Soco lie about 20 miles east of Morro Velho, on the opposite side of the Velhas, and were at one time very productive. Another company owns a tract of 21 square miles, not far from the Morro Velho. Other mines have been worked in this neighbourhood at the Morro de Sta Anna, at Maquiné near it, and in the Serra of Cata Branca, 2 miles east of the village of Corrego Seco. These mines with two exceptions have proved failures in working, after a period of success, and this notoriously from bad management. The mines, however, are very far from being exhausted; indeed the underground wealth of the country is as yet almost untouched. Much of the remaining portion of the province of Minas, and especially the upper basin of the São Francisco, is auriferous. In Northern Brazil the only gold mine yet opened is that of Tury-assú in the province of Maranhão; but concessions for working gold have been granted by Government in many parts of the provinces of Bahia, Pernambuco, Parahyba, Piauhy, Goyaz, Ceará, and S. Paulo. In southern Brazil gold is known at Caçapava, Rio Pardo, Sta. Maria, and Cruz Alta, in the province of Rio Grande do Sul; and at the first-named locality a Brazilian company is carrying on the work of mining. Gold washings occur in almost every province, but especially in the district of Minas Novas, 200 miles north of Ouro Preto, where the metal is found in grains or nuggets in a *cascalho* of quartz pebbles, often cemented into a conglomerate by iron oxide. They are carried on, however, in the rudest and most irregular way, and with more modern appliances might prove very remunerative Gold.

The gold of Brazil is always alloyed with silver, and this metal is present in many of the galenic formations which are known in almost every province, as well as with the copper in the mines of Rio Grande do Sul. At the hill of Araçoiva, in the municipality of Sorocaba in São Paulo, silver was extracted nearly two centuries ago. Rich mines of mercury occur in the province of Paraná not far from the capital. Copper is abundant in the provinces of Matto Grosso, Goyaz, and Minas, near the capital of Bahia, in Maranhão and Ceará, but chiefly in Rio Grande do Sul, where at Santo Antonio das Lavras, in the municipality of Silver. Mercury. Copper.

Caçapava, there are the richest copper mines of Brazil, the mineral from which yields 60 per cent. of pure metal.

ganese. Manganese exists in abundance in the vicinity of Nazareth, at the head of the estuary of the Jaguaripe, nn. adjoining the bay of Bahia. Galena mines are in operation in many parts of the empire; the chief are those of Iporanga, Sorocaba, Iguapé in the province of São Paulo, and those of the Rio Abaeté and Sete Lagôas, the most productive of l. all, in the province of Minas. Lead mines also exist along the whole coastal region from Santa Catharina to Maranhão, those of the hill chain of Ibiapaba on the borders of Ceará and Piauhy being important.

l. Every part of Brazil contains iron, in ore or in other forms, and an almost unlimited quantity appears to exist in the mountains of Minas Geraes. At São João de Ipanéma, in S. Paulo, there are heavy deposits of magnetic iron, which are mined and smelted almost on the spot; and other seams of like character appear in the provinces of Alagôas, Ceará, Rio Grande do Norte, and Parahyba. Some of the Brazilian mines are quite free from pyrites. In 1810 a company of Swedish miners and founders settled at Ipanéma, and erected two small refining furnaces. In 1817 they produced nearly 4000 arrobas of iron, which was manufactured on the spot into horses' shoes, nails, locks, and other articles. There is now a very considerable establishment, at which moulding and refining is carried on, the woods of the neighbourhood furnishing an abundant supply of charcoal. A railway is projected to unite the works with S. Paulo and its port. Not far from these mines there are extensive quarries of marble of valuable sorts.

MATE. A country so extensive as Brazil, and so diversified in its surface, necessarily exhibits a considerable variety of climate. The great northern lowland lying entirely within the tropics has great heat, and its year is divided between the simple wet and dry seasons. The elevation of the central and southern highland of Brazil introduces great variety in the seasons and climates of the intertropical portion of that region; and towards the south beyond the tropic a temperate zone is reached in which four seasons are marked, nfall. though not so distinctly as in central Europe. The whole wide plain of the Amazon basin has its rainy season from January or December till May or June, the remaining half of the year being dry, though intervals of fine weather may occur within the wet period, and of showers in the dry season. The fall during the rainy months is excessive, raising the level of the great river full 40 feet, and much thunder and lightning always accompanies the heavy rain. This belt of single rainy and dry season appears to terminate about the line of the River Paranahyba, between the provinces of Maranhão and Piauhy; at the town of Maranhão the annual fall has been found to be on an average 280 inches. Inland, across the higher southern watershed of the Amazon, from the interior of the provinces of Maranhão and Piauhy, over Goyaz and northern Matto Grosso as far as the falls of the Madeira, the rainy seasons follow the passage of the sun towards and away from the southern tropic, and occur from October or November to March or April, with more or less marked intervals of drier weather.

In lower Maranhão showers also occur in October, and are called the 'Cashew rains.' On the north-east coast slope, in the provinces of Ceará, Rio Grande do Norte, and northern Bahia, the rains appear to be governed by the prevalence of the north-east winds from the Atlantic, and occur from March or April to June, July, or August. The coastal region from southern Bahia to São Paulo and the São Francisco valley have again a more or less marked double rainy season between October and April or May; the heaviest rains occur in the São Francisco valley from January to May, the highest freshets of the river being in March; the coast rivers, such as the Rio Doce, rise first in December, and again to an almost equal swelling in March. At Pernambuco the amount of the annual rainfall is upwards of 100 inches; at Rio de Janeiro it has decreased to 59 inches, and a gradual diminution of the quantity is observed from the Amazon southward. In São Paulo the rainy season is, in summer, from November till April, the greatest quantity of rain falling in January. In Sta. Catharina the rains begin to be irregular, and from this to the southward over Rio Grande do Sul the four seasons of the temperate zone begin to be distinguishable. The whole country is, as a rule, abundantly watered, the only portion which may suffer from drought being that of the interior between the São Francisco and the Paranahyba, where extraordinary dryness has sometimes prevailed.

In temperature the vast Amazon basin is remarkable for Temperature. the small seasonal variation of heat, accounted for by its equatorial position and immense surface of water and forest; within its limits the thermometer at its highest readings averages 90° and the lowest 75°. At Pará the register kept by Costa Azevedo between 1861 and 1867 gave a mean temperature of 80°, a maximum of 95°, and a minimum of 68°. Observations are very deficient for the greater portion of the empire. About the Falls of the Madeira, Keller estimates the mean annual temperature at 77°, with but small variation in the seasons. In the latitude of Rio de Janeiro the summer or January temperature near the sea-level has an average of about 75°, that of July descending to about 65°; and in the extreme southern provinces the corresponding figures may fall to 70° and 50° Fahr. in summer and winter. But an immense variety of temperature and climatic condition are found on the central and southern table-lands and mountain ranges of Brazil, from the hot and humid air of the coast to the mountains where in winter it frequently snows, and where lakes may be covered with a coating of ice. In the high plains of Rio Grande and São Paulo the thermometer may also fall to below the freezing point.

The prevalent winds of the greater portion of Brazil are Winds. the trade-winds from the east, which, gathering the vapours from the whole breadth of the equatorial Atlantic, give out their excessive moisture over the northern forest plains of the Amazon, reaching inland as far as the high wall of the Andes. The east winds are strongest in the Amazon valley from July till November, mitigating the heat of the dry season. On the maritime regions of central Brazil the north-east or south-east trades prevail according to season. In the far interior the general winds take a more north and south direction, blowing usually from the south when the sun is in the northern tropic and from the north during summer. Land and sea breezes are very constant along the coasts. At the mouth of the São Francisco, for example, the morning is still and calm; about nine o'clock a breeze steals over the water, rippling its surface and gradually increasing to a stiff wind about noon; the breeze continues steadily till night-fall, when it again falls calm.

With the exception of the marshy banks of some of the Health. rivers and the lowlands and swamps, where intermittent fevers are very prevalent, the country is generally healthy. On the sea-coast and inland in some of the maritime provinces, epidemics of yellow fever and cholera morbus have been experienced since 1850. The mortality in the most populous towns of Brazil is not, however, above but rather below that of the large cities of Europe.

The broadly-marked features given to the landscape by VEGETATION. the vegetations of different characters in Brazil are distinguished by several names. *Mattas* or heavy forests cover the immense northern lowland which is watered by excessive rains, and these occur also in belts of greater or less width over the lower portions of the central and southern

region. *Catinga* is the general name applied to the lower growing and open woods of the slopes of the Brazilian highland which lose their leaves in the dry season. These merge into the wide open plains or gently rounded hills and ridges, covered with grass or scattered bushes, which are called the *Campos geraes*. The systematic burning over of these great grass lands, to allow the young crop to appear, has completely destroyed in them all trees and shrubs which cannot bear the scorching, and so has wrought a great alteration in the flora of these regions. The name *Sertão*, meaning originally the interior as distinguished from the maritime country, has come to be applied to dry, hilly, and stony districts of the campos only suited for pasture. To the agricultural coast belt of the eastern provinces the name *Beira mar* is given.

Except on the loftiest mountains, and on the wide *sertãos*, the vegetation of Brazil is luxuriant beyond description. In the mountain passes in the neighbourhood of the sea-shore, the conjoint effects of heat and moisture produce a superfluity of vegetable life, which man's utmost efforts cannot restrain. Trees split for paling in the neighbourhood of Rio Janeiro send forth shoots and branches immediately, and this whether the position of the fragments be that in which they originally grew, or inverted. On the banks of the Amazons the loftiest trees destroy each other by their proximity, and are bound together by rich and multiform lianes. In the province of Maranhão, the roots, grasses, and other plants extending from the shores of pools, weave themselves in time into a kind of vegetable bridge, along which the passenger treads, unaware that he has left the firm earth, until the jaws of a cayman protrude through the herbage before him. The vegetable productions of Brazil have a strong analogy with those of Guiana. The most common are the *Compositæ*, *Leguminosæ*, *Euphorbiaceæ*, *Rubiaceæ*, *Aroideæ*, and ferns of the most varied forms. The vegetation of the valleys differs from that of the *campos*, as it again does from that which occurs in the *sertãos*. Along the coast, the mangroves are the most numerous and prominent species. The most marked peculiarity of this class of plants is, that the seeds begin to shoot before they drop from the parent plant, and that the drooping branches strike roots into the soil. They are never found inland except where the surface is scarcely elevated above the level of the sea. They flourish from Rio Grande do Sul to Maranhão, converting the land into a morass wherever they are allowed to flourish unmolested. Immediately behind them numerous families of palms raise their graceful heads. The underwood in the neighbourhood of Rio Janeiro consists principally of crotons. Every large river of Brazil has its own appropriate form of vegetable life, giving a peculiar character to its banks. The vegetation of the Amazon may be divided into three classes;—(1) that which we find on the islands, (2) the vegetation upon the banks overflowed at regular intervals by the stream, and (3) that which stands high and dry. The difference between them consists in the character of the bark and the species of the plants. Brushwood and herbage are nowhere to be seen; everything tends to the gigantic in size. The most various forms group awkwardly together, crossed and intertwined with leaves. The preponderance of trees with feathery foliage, and with glossy, fleshy leaves, lends alternately a tender and a luxuriant character to the scene, which is in every other respect painful from its monotony. Representatives of the most estranged natural families grow side by side. It is only on the islands, where the willow and some other plants are found in numbers, that we are reminded of the uniformity of our northern vegetation. Cocoa trees and the vanilla, *Capsicum frutescens*, and different kinds of pepper, the cinnamon tree, and Brazilian cassia abound. The flora of all the tributaries of the Amazon is similar to what we have described, until the traveller ascends above the falls, and finds himself in another region. The sources of the Madeira alone offer a partial exception, retaining a vegetation indicative of extensive plains, lakes, and morasses. The vegetation of the southern *campos* (corresponding to the North American *prairies*) is widely different. On the plains of the southern provinces we find scattered about strong tufts of greyish-green and hairy grasses, springing from the red clay. Mingled with these are numerous herbaceous flowers, of the most varied colours and elegant forms. At intervals small groves of trees, seldom exceeding 20 feet in height, so distant that the individual form of each is easily recognized, with spreading fantastic branches and pale green leaves, break the monotony of the scene. Solitary myrtles, numerous varieties of pleasing fruits, and now and then a cactus, add to the variety. A similar vegetation, but with a richer variety of plants, occurs in the diamond district. On the western declivity of the Serra do Mar, and along the upper banks of the Rio São Francisco, extends a wooded "catinga" country, of a character entirely different from that which is found in the valleys below. *Malvæ*, *Euphorbiaceæ*, *Mimosæ*, and the like, are the prevailing types on the Rio Francisco; cactuses, palms, and ferns abound on the Serra do Mar. In this latter district the ipecacuanha flourishes best. It is, however, in the glowing steppes of Pernambuco that we find the cactus predominant. In the valley of the Paraguay the most striking feature is presented by the water plants, which in one river are sufficiently strong to impede the navigation of a stream both deep and broad.

The forests of Brazil contain almost every species of useful and ornamental wood. The cocoa-tree is found in great quantities in the provinces on the sea-shore, and furnishes one of the most important items of internal commerce. A considerable surplus of cocoa is annually exported. One of the most valuable sorts of timber is furnished by the Ibiripitanga or Brazil-wood (*Cæsalpinia brasiliensis*), which yields a fine red dye. The wood itself is very hard and heavy, and takes a beautiful polish. It grew at one time in great abundance along the coast; but being a Government monopoly (thence called *pao da rainho*, Queen's wood), it was cut down in a reckless manner, and is now by no means so abundant as it once was. The other trees most worthy of mention are the *jaracandá* or rosewood tree, the trumpet-tree (*Secropia peltata*), the laurel, the soap-tree, the tapia or garlic pear-tree, and the whole family of palms. Of these the Carnauba Palm (*Copernicia cerifera*), which grows in the north-east coastal province, is perhaps the most useful tree of Brazil; every part of it is valuable, and the wax yielded by its leaves is now a considerable article of trade. Not least important is the *Siphonia elastica*, or caoutchouc tree, which during the season is tapped every day, and furnishes in considerable quantities a gum which is poured into moulds; the export of this product from Brazil averages a value of more than £1,000,000 annually. The banana is one of the most useful of all the trees that grow in Brazil, and its fruit is the chief food of the native Indians. The fruits of Brazil are numerous and excellent. The best of these are the pine-apple, the mango, the custard-apple, the guava, and the various kinds of melons and nuts.

In an empire of such vast extent as Brazil, embracing as it does every variety of temperature and elevation, the value and importance of the agricultural products cannot fail to be very great. So small, however, is the number of farmers, compared with the extent of the soil, that it is believed that not one acre in 200 is under cultivation. In some provinces, especially those near the sea, the quantity of grain raised is not sufficient to supply the

Vegetable products.

demand, and thus large quantities of wheat are annually imported from the United States. The reason of this is that the soil under tillage is occupied in the production of articles for foreign markets. The chief products of Brazil are coffee, sugar, cotton, manioc or cassava flour, tobacco, rice, maize, fruits, and spices. Of these by far the most important now is coffee, while sugar ranks next in value, and cotton after sugar.

ffee. The coffee plant, introduced from Arabia into the French colony of Cayenne in 1722, was soon after brought to Brazil; but it was not until 1810 that Brazilian coffee came to be highly valued in the European markets. In that year, however, Dr Lecesne, a planter, expelled by the revolution from San Domingo, settled near Rio, and introduced the most improved methods of rearing the coffee-plant. So successful has the result of the new system been, that its cultivation now extends from the Amazon to São Paulo; and whereas in 1818 the annual exports of coffee did not amount in value to £240,000, in 1873 the exports were worth nearly £13,000,000.

igar. The cultivation of sugar has not increased nearly in the same proportion as that of coffee, and in recent years a disease of the cane has affected the cultivation seriously. It is produced in greatest quantity in the districts adjoining Bahia. The quantity of sugar exported in 1850 was 16,200 bales, representing a value of about £1,700,000; in 1873 the value of the exports was £3,120,000.

tton. Cotton is found to thrive best in the dry table-lands of the northern provinces, especially in Maranhão and Pernambuco. Its quality is considered excellent; but the rude and expensive method of its culture, and the high rates of carriage in these inland districts, operate very unfavourably for this branch of traffic. The annual value of cotton exported is not much above £3,000,000.

her products. The *Ilex curitibensis*, and other varieties of the holly, which yields the yerba maté, or Paraguay tea, are indigenous to the southern provinces of Rio Grande, Santa Catharina, and Paraná Some attempts have been made towards the cultivation of this product, but the greater part of the tea is rudely made from the tree in its wild state in the woods. The amount annually exported to the River Plate averages between £300,000 to £400,000 in value. Tobacco is chiefly cultivated in the provinces of Bahia, Minas, S. Paulo, and Pará, and in some localities of Rio de Janeiro. Though it is inferior in quality to that of the West Indies, it is exported to the value of between £700,000 and £800,000 annually. The cultivation of cocoa, hitherto obtained from the valleys of the Amazon and Tocantins, is increasing in the provinces of Bahia and Ceará. Rice grows in considerable quantities, and not being much used by the natives for food, a large surplus remains for exportation. The cassava or manioc is extensively grown and forms the staple food of the lower classes The root, which is the part of the plant used for this purpose, contains a deadly poison. It is easily expelled, however, by the action of fire, and the residuum is ground into a wholesome and nutritious flour or farina Tapioca, which is extensively used in Europe, is a preparation of the starch from the root of the cassava.

imals. The varieties of animated life in Brazil are more numerous perhaps than in any other region in the world. Of beasts of prey, the most formidable are the jaguar or South American tiger, the ocelot, the tiger-cat, the puma, the guará or red wolf, and the Brazilian fox or wild dog. Large herds of the peccary roam in the forests, in which also is to be found the tapir or *anta*, the largest South American mammal. The *capivara*, or water hog, abundant on the river banks, is the largest known rodent. Diverse species of deer inhabit the campos; representing the Edentata there are several species of armadillos and ant-eaters, and the sloths; and of the Marsupialia, several species of opossum occurring over the whole of Brazil. The varieties of the monkey tribe that abound in the forests appear to be almost infinite. The largest belong to the genus *Stentor*, including the guaribas or howling monkeys. The *Simia jacchus* has never been seen elsewhere. There are several varieties of bats, of which the *Vespertilio leporinus* and the *V. spectrum* are the largest. No less immense is the variety of birds, from the *ouira*, an eagle far larger than our most powerful birds of prey, to the humming-bird, no larger than a bee. The rhea, a species of ostrich, is found in Brazil. The Brazilian birds are celebrated for the beauty of their plumage. "Red, blue, and green parrots," says Malte-Brun, "frequent the tops of trees. The gallinaceous *jacús*, the *hoccos*, and different kinds of pigeons, haunt the woods. The orioles resort to the orange groves; and their sentinels, stationed at a distance, announce with a screaming noise the approach of man. Chattering manakins mislead the hunter; and the metallic tones of the uraponga resound through the forest like the strokes of a hammer on an anvil. The toucan (*Ramphastos*) is prized for its feathers, which are of a lemon and bright red colour, with transverse stripes reaching to the extremities of the wings. The different species of humming birds are more numerous in Brazil than in any other country of America. One sort is called by the people the *Gnanthe engera* or winged flower." Snakes of every kind abound in the marshy districts, some of which, such as the rattlesnake and the jararaca, are remarkably venomous; while others, such as the boas, attain an enormous size and strength. A vast number of troublesome insects infest the margins of all the great rivers. Of these the most formidable is the *puim*, which is so small as to be scarcely visible, and inflicts a most painful and even dangerous bite. The red ant is peculiarly destructive to vegetation, and whole districts are sometimes laid waste by its ravages. The spider here attains an enormous size, but is not so venomous as might be expected from its appearance. The gayest butterflies flutter through the air,—the blue shining Menelaus, the Adonis, the Nestor, and the Laertes. More than ten species of wild bees have been observed in the woods, and the greater number produce honey. The *Cactus coccinellifer*, and the insect peculiar to it, are found in the province of S. Paulo. Lizards and caymans abound. The quantity of turtle in the Amazon and its principal tributaries is almost incredible. The waters swarm with fish in thousands of species, many of which have not yet been described. Among the largest is the *Pira rucú*, the principal food of large numbers of the people of Pará and Amazonas. Of domestic animals, the most important are the horse, the ox, and the sheep. Vast numbers of horses, sprung from the original European stock, roam at large over the extensive plains of the southern provinces. They are generally found in droves of twenty or thirty. Oxen are also allowed to wander half wild. They are hunted down with the *lasso* in great numbers, and are valued chiefly on account of their hides, horns, and tallow, which are exported in immense quantities. The chief cattle-breeding districts of Brazil are the island of Marajo in Pará, Goyaz, Matto Grosso, Piauhy, S. Paulo, Minas, Paraná, and Rio Grande do Sul. Sheep do not thrive in Brazil at all so well as the larger kinds of cattle.

History. Brazil was discovered in 1499 by Vincent Yañez Pinçon, a companion of Columbus. He descried the land near Cape St Augustinê, and sailed along the coast as far as the River Amazon, whence he proceeded to the mouth of the Orinoco. He made no settlement, but took possession of the country in the name of the Spanish Government, and carried home, as specimens of its natural productions, some drugs, gems, and Brazil-wood. Next year the Portuguese commander, Pedro Alvarez Cabral,

appointed by his monarch to follow the course of Vasco de Gama in the East, was driven by adverse winds so far from his track, that he reached the Brazilian coast, April 24, and anchored in Porto Seguro (16° S. lat.) on Good Friday. On Easter day an altar was erected, mass celebrated in presence of the natives, the country declared an apanage of Portugal, and a stone cross erected in commemoration of the event. Cabral despatched a small vessel to Lisbon to announce his discovery, and, without forming any settlement, proceeded to India on the 3d of May. On the arrival of the news in Portugal, Emanuel invited Amerigo Vespucci to enter his service, and despatched him with three vessels to explore the country. This navigator's first voyage was unsuccessful; but in a second he discovered a safe port, the site of which is not accurately known, to which he gave the name of All-Saints. He remained there five months, and maintained a friendly intercourse with the natives. Some of the party travelled forty leagues into the interior. Vespucci erected a small fort, and leaving twelve men, with guns and provisions, to garrison it, embarked for Portugal, having loaded his two ships with Brazil-wood, monkeys, and parrots.

The poor and barbarous tribes of Brazil, and their country, the mineral riches of which were not immediately discovered, offered but few attractions to a Government into the coffers of which the wealth of India and Africa was flowing. Vespucci's settlement was neglected. For nearly thirty years the kings of Portugal paid no further attention to their newly-acquired territory than what consisted in combating the attempts of the Spaniards to occupy it, and dispersing the private adventurers from France who sought its shores for the purposes of commerce. The colonization of Brazil was prosecuted, however, by subjects of the Portuguese monarchy, who traded thither chiefly for Brazil-wood. The Government also sought to make criminals of some use to the state, by placing them in a situation where they could do little harm to society, and might help to uphold the dominion of their nation.

The first attempt on the part of a Portuguese monarch to introduce an organized government into his dominions was made by João III. He adopted a plan which had been found to succeed well in Madeira and the Azores,—dividing the country into hereditary captaincies, and granting them to such persons as were willing to undertake their settlement, with unlimited powers of jurisdiction, both civil and criminal. Each captaincy extended along fifty leagues of coast. The boundaries in the interior were undefined. The first settlement made under this new system was that of S. Vincente Piratininga, in the present province of S. Paulo. Martim Affonso de Sousa, having obtained a grant, fitted out a considerable armament, and proceeded to explore the country in person. He began to survey the coast about Rio de Janeiro, to which he gave that name, because he discovered it on the first of January 1531. He proceeded south as far as La Plata, naming the places he surveyed on the way from the days on which the respective discoveries were made. He fixed upon an island, in 24½° S. lat., called by the natives Guaibe, for his settlement. The Goagnazes, or prevailing tribe of Indians in that neighbourhood, as soon as they discovered the intentions of the new comers to fix themselves permanently there, collected for the purpose of expelling them. Fortunately, however, a shipwrecked Portuguese, who had lived many years under the protection of the principal chief, was successful in concluding a treaty of perpetual alliance between his countrymen and the natives. Finding the spot chosen for the new town inconvenient, the colonists removed to the adjoining island of S. Vincente, from which the captaincy derived its name. Cattle and the sugar-cane were at an early period introduced from Madeira, and here the other captaincies supplied themselves with both.

Pero Lopes de Sousa received the grant of a captaincy, and set sail from Portugal at the same time as his brother, the founder of S. Vincente. He chose to have his fifty leagues in two allotments. That to which he gave the name of S. Amaro adjoined S. Vincente, the two towns being only three leagues asunder. The other division lay much nearer to the line between Paraiba and Pernambuco. He experienced considerable difficulty in founding this second colony, from the strenuous opposition of a neighbouring tribe, the Petiguares; but at length he succeeded in clearing his lands of them; and not long afterwards he perished by shipwreck.

Rio de Janeiro was not settled till a later period; and for a considerable time the nearest captaincy to S. Amaro, sailing along the coast northwards, was that of Espiritu Santo. It was founded by Vasco Fernandes Coutinho, who having acquired a large fortune in India, sunk it in this scheme of colonization. He carried with him no less than sixty fidalgos. They named their town by anticipation, Our Lady of the Victory; but it cost them some hard fighting with the Goagnazes to justify the title.

Pedro de Campo Tourinho, a nobleman and excellent navigator, received a grant of the adjoining captaincy of Porto Seguro. This, it will be remembered, is the spot where Cabral first took possession of Brazil. The Tupinoquins at first offered some opposition; but having made peace, they observed it faithfully, notwithstanding that the oppression of the Portuguese obliged them to forsake the country. Sugar-works were established, and considerable quantities of the produce exported to the mother country.

Jorge de Figueiredo, *Escrivam da Fazenda*, was the first donatory of the captaincy of Ilhéos, 140 miles S. of Bahia. His office preventing him from taking possession in person, he deputed the task to Francisco Romeiro, a Castilian. The Tupinoquins, the most tractable of the Brazilian tribes, made peace with the settlers, and the colony was founded without a struggle.

The coast from the Rio S. Francisco to Bahia was granted to Francisco Pereira Coutinho; the bay itself, with all its creeks, was afterwards added to the grant. When Coutinho formed his establishment, where Villa Velha now stands, he found a noble Portuguese living in the neighbourhood who, having been shipwrecked, had, by means of his fire-arms, raised himself to the rank of chief among the natives. He was surrounded by a patriarchal establishment of wives and children; and to him most of the distinguished families of Bahia still trace their lineage. The regard entertained by the natives for Caramuru (signifying *man of fire*) induced them to extend a hospitable welcome to his countrymen, and for a time everything went on well. Coutinho had, however, learned in India to be an oppressor, and the Tupinambas were the fiercest and most powerful of the native tribes. The Portuguese were obliged to abandon their settlement; but several of them returned at a later period, along with Caramuru, and thus a European community was established in the district.

Some time before the period at which these captaincies were established, a factory had been planted at Pernambuco. A ship from Marseilles took it, and left seventy men in it as a garrison; but being captured on her return, and carried into Lisbon, immediate measures were taken for reoccupying the place. The captaincy of Pernambuco was granted to Don Duarte Coelho Pereira as the reward of his services in India. It extended along the coast from the Rio S. Francisco, northward to the Rio de Juraza. Duarte sailed with his wife and children, and many of his kinsmen, to take possession of his new colony, and landed in the port of Pernambuco. To the town which was there founded he gave the name of

Olinda. The Cabetes, who possessed the soil, were fierce and pertinacious; and, assisted by the French, who traded to that coast, Coelho had to gain by inches what was granted him by leagues. The Portuguese managed, however, to beat off their enemies; and, having entered into an alliance with the Tobayanes, followed up their success.

Attempts were made about this time to establish two other captaincies, but without success. Pedro de Goes obtained a grant of the captaincy of Paraiba between those of S. Vincente and Espirito Santo; but his means were too feeble to enable him to make head against the aborigines, and the colony was broken up after a painful struggle of seven years. João de Barros, the historian, obtained the captaincy of Maranhão. For the sake of increasing his capital, he divided his grant with Fernan Alvares de Andrada and Aires da Cunha. They projected a scheme of conquest and colonization upon a large scale. Nine hundred men, of whom one hundred and thirteen were horsemen, embarked in ten ships under the command of Aires da Cunha. But the vessels were wrecked upon some shoals about one hundred leagues to the south of Maranhão; the few survivors, after suffering immense hardships, escaped to the nearest settlements, and the undertaking was abandoned.

By these adventurers the whole line of Brazilian coast, from the mouth of La Plata to the mouth of the Amazon, had become studded at intervals with Portuguese settlements, in all of which law and justice were administered, however inadequately. It is worthy of observation, that Brazil was the first colony founded in America upon an agricultural principle, for until then the precious metals were the exclusive attraction. Sufficient capital was attracted between the year 1531 (in which De Sousa founded the first captaincy) and the year 1548 to render these colonies an object of importance to the mother country. Their organization, however, in regard to their means of defence against both external aggression and internal violence, was extremely defective. Their territories were surrounded and partly occupied by large tribes of savages. Behind them the Spaniards, who had an establishment at Asuncion, had penetrated almost to the sources of the waters of Paraguay, and had succeeded in establishing communication with Peru. Orellana, on the other hand, setting out from Peru, had crossed the mountains and sailed down the Amazon. Nor had the French abandoned their hopes of effecting an establishment on the coast.

The obvious remedy for these evils was to concentrate the executive power, to render the petty chiefs amenable to one tribunal, and to confide the management of the defensive force to one hand. In order to this the powers of the several captains were revoked, whilst their property in their grants was reserved to them. A governor-general was appointed, with full powers, civil and criminal. The judicial and financial functions in each province were vested ı the *Ouvidor*, whose authority in the college of finance as second only to that of the goveɪnor. Every colonist as enrolled either in the *Milicias* or *Ordenanzas*. The ɪrmer were obliged to serve beyond the boundaries of the :ovince, the latter only at home. The chief cities received .unicipal constitutions, as in Portugal. Thome de Sousa as the first person nominated to the important post of ɔvernor-general. He was instructed to build a strong city ı Bahia and to establish there the seat of his government. ı pursuance of his commission he arrived at Bahia in pril 1549, with a fleet of six vessels, on board of which ere three hundred and twenty persons in the king's pay, ɪur hundred convicts, and about three hundred free ɔlonists. Care had been taken for the spiritual wants of ıe provinces by associating six Jesuits with the expeition.

Old Caramaru, who still survived, rendered the governor essential service by gaining for his countrymen the good will of the natives. The new city was established where Bahia still stands. Within four months one hundred houses were built, and surrounded by a mud wall. Sugar plantations were laid out in the vicinity. During the four years of Sousa's government there were sent out at different times supplies of all kinds, female orphans of noble families, who were given in marriage to the officers, and portioned from the royal estates, and orphan boys to be educated by the Jesuits. The capital rose rapidly in importance, and the captaincies learned to regard it as a common head and centre of wealth. Meanwhile the Jesuits undertook the moral and religious culture of the natives, and of the scarcely less savage colonists. Strong opposition was at first experienced from the gross ignorance of the Indians, and the depravity of the Portuguese, fostered by the licentious encouragement of some abandoned priests who had found their way to Brazil. Over these persons the Jesuits had no authority; and it was not until the arrival of the first bishop of Brazil in 1552, that anything like an efficient check was imposed upon them. Next year Sousa was succeeded by Duarte da Costa, who brought with him a reinforcement of Jesuits, at the head of whom was Luis de Gran, appointed, with Nobrega the chief of the first mission, joint provincial of Brazil.

Nobrega's first act was one which has exercised the most beneficial influence over the social system of Brazil, namely, the establishment of a college on the then unreclaimed plains of Piratininga. It was named S. Paulo, and has been at once the source whence knowledge and civilization have been diffused through Brazil, and the nucleus of a colony of its manliest and hardiest citizens, which sent out successive swarms of hardy adventurers to people the interior. The good intentions of the Jesuits were in part frustrated by the opposition of Duarte the governor; and it was not until 1558, when Mem de Sa was sent out to supersede him, that their projects were allowed free scope.

Rio de Janeiro was first occupied by French settlers. Nicholas Durand de Villegagnon, a bold and skilful seaman, having visited Brazil, saw at once the advantages which might accrue to his country from a settlement there. In order to secure the interest of Coligny, he gave out that his projected colony was intended to serve as a place of refuge for the persecuted Huguenots. Under the patronage of that admiral, he arrived at Rio de Janeiro in 1558 with a train of numerous and respectable colonists. As soon, however, as he thought his power secure, he threw off the mask, and began to harass and oppress the Huguenots by every means he could devise. Many of them were forced by his tyranny to return to France; and ten thousand Protestants, ready to embark for the new colony, were deterred by their representations. Villegagnon, finding his force much diminished in consequence of his treachery, sailed for France in quest of recruits; and during his absence the Portuguese governor, by order of his court, attacked and dispersed the settlement. For some years the French kept up a kind of bush warfare; but in 1567 the Portuguese succeeded in establishing a settlement at Rio.

Mem de Sa continued to hold the reins of government in Brazil upon terms of the best understanding with the clergy, and to the great advantage of the colonies, for fourteen years. On the expiration of his power, which was nearly contemporary with that of his life, an attempt was made to divide Brazil into two governments; but this having failed, the territory was reunited in 1578, the year in which Diego Laurenço da Veiga was appointed governor. At this time the colonies, although not yet independent of supplies from the mother country, were in a flourishing condition; but the usurpation of the crown

of Portugal by Philip II. changed the aspect of affairs. Brazil, believed to be inferior to the Spanish possessions in mines, was consequently abandoned in comparative neglect for the period intervening between 1578 and 1640, during which it continued an apanage of Spain.

No sooner had Brazil passed under the Spanish crown, than English adventurers directed their hostile enterprises against its shores. In 1586 Witherington plundered Bahia; in 1591 Cavendish burned S. Vincente; in 1595 Lancaster took Olinda. These exploits, however, were transient in their effects. In 1612 the French attempted to found a permanent colony in the island of Marajó, where they succeeded in maintaining themselves till 1618. This attempt led to the erection of Maranhão and Pará into a separate *Estado*. But it was on the part of the Dutch that the most skilful and pertinacious efforts were made for securing a footing in Brazil; and they alone of all the rivals of the Portuguese have left traces of their presence in the national spirit and institutions of Brazil.

The success of the Dutch East India Company led to the establishment of a similar one for the West Indies, to which a monopoly of the trade to America and Africa was granted. This body despatched in 1624 a fleet against Bahia. The town yielded almost without a struggle. The fleet soon after sailed, a squadron being detached against Angola, with the intention of taking possession of that colony, in order to secure a supply of slaves The Portuguese, in the meanwhile, began to collect for the purpose of expelling the permanent intruders, and the hearty co-operation of all the natives against the invaders having been obtained through the descendants of Caramaru, the Dutch were obliged to capitulate in May 1625. The honours bestowed upon the Indian chiefs for their assistance in this war broke down in a great measure the barrier between the two races; and there is at this day a greater admixture of their blood among the better classes in Bahia than is to be found elsewhere in Brazil.

In 1630 the Dutch attempted again to effect a settlement; and Olinda yielded after a feeble resistance. They were unable, however, to extend their power beyond the limits of the town, until the arrival of Count Maurice of Nassau in 1630. His first step was to introduce a regular government among his countrymen; his second, to send to the African coast one of his officers, who took possession of a Portuguese settlement, and thus secured a supply of slaves. In the course of four years, the limited period of his government, he succeeded in confirming the Dutch supremacy along the coast of Brazil from the mouth of the S. Francisco to Maranhão. He promoted the amalgamation of the different races, and sought to conciliate the Portuguese by the confidence he reposed in them. His object was to found a great empire; but this was a project at variance with the wishes of his employers—an association of merchants, who were dissatisfied because the wealth which they expected to see flowing into their coffers was expended in promoting the permanent interests of a distant country. Count Maurice was recalled in 1644 His successors possessed neither his political nor his military talents, and had to contend with more energetic enemies.

In 1640 the revolution which placed the house of Bragança on the throne of Portugal restored Brazil to masters more inclined to promote its interests and assert its possession than the Spaniards. It was indeed high time that some exertion should be made. The northern provinces had fallen into the power of Holland; the southern, peopled in a great measure by the hardy descendants of the successive colonists who had issued on all sides from the central establishment of S. Paulo, had learned from their habits of unaided and successful enterprise to court independence. They had ascended the waters of the Paraguay to their sources. They had extended their limits southwards till they reached the Spanish settlements on La Plata. They had reduced to slavery numerous tribes of the natives. They were rich in cattle, and had commenced the discovery of the mines. When, therefore, the inhabitants of S. Paulo saw themselves about to be transferred, as a dependency of Portugal, from one master to another, they conceived the idea of erecting their country into an independent state. Their attempt, however, was frustrated by Amador Bueno, the person whom they had selected for their king. When the people shouted "Long live King Amador," he cried out "Long live João IV.," and took refuge in a convent. The multitude, left without a leader, acquiesced, and this important province was secured to the house of Bragança.

Rio and Santos, although both evinced a desire of independence, followed the example of the Paulistas. Bahia, as capital of the Brazilian states, felt that its ascendency depended upon the union with Portugal. The Government thus left in quiet possession of the rest of Brazil, had time to concentrate its attention upon the Dutch conquests. The crown of Portugal was, however, much too weak to adopt energetic measures. The tyranny of the successors of Nassau, by alienating the minds of the Portuguese and natives, drove them to revolt before any steps were taken in the mother country for the reconquest of its colonies. João Fernandes Vieyra, a native of Madeira, organized the insurrection which broke out in 1645. This insurrection gave birth to one of those wars in which a whole nation, destitute of pecuniary resources, military organization, and skilful leaders, is opposed to a handful of soldiers advantageously posted and well officered. But brute force is unable to contend with scientific valour. Vieyra, who had the sense to see this, repaired to the court of Portugal, and discovering the weakness and poverty of the executive, suggested the establishment of a company similar to that which in Holland had proved so successful. His plan, notwithstanding the opposition of the priests, was approved of, and in 1649 the Brazil Company of Portugal sent out its first fleet. After a most sanguinary war, Vieyra was enabled in 1654 to present the keys of Olinda to the royal commander, and to restore to his monarch the undivided empire of Brazil. After this, except some inroads on the frontiers, the only foreign invasion which Brazil had to suffer was from France. In 1710 a squadron, commanded by Duclerc, disembarked 1000 men, and attacked Rio de Janeiro. After having lost half of his men in a battle, Duclerc and all his surviving companions were made prisoners. The governor treated them cruelly. A new squadron with 6000 troops was intrusted to the famous admiral Duguay Trouin to revenge this injury. They arrived at Rio on the 12th September 1711. After four days of hard fighting the town was taken. The governor retreated to a position out of it, and was only awaiting reinforcements from Minas to retake it; but Duguay Trouin threatening to burn it, he was obliged on the 10th October to sign a capitulation, and pay to the French admiral 610,000 crusados, 500 cases of sugar, and provisions for the return of the fleet to Europe. Duguay Trouin departed to Bahia to obtain fresh spoils; but having lost in a storm two of his best ships, with an important part of the money received, he renounced this plan and returned directly to France.

After this the Portuguese governed undisturbed their colony. The approach of foreign traders was prohibited, while the regalities reserved by the crown drained the country of a great proportion of its wealth.

The important part which the inhabitants of São Paulo have played in the history of Brazil has been already adverted to. The establishment of the Jesuit college had attracted settlers to its neighbourhood, and frequent

marriages had taken place between the Indians of the district and the colonists. A hardy and enterprising race of men had sprung from this mixture, who, first searching whether their new country were rich in metals, soon began adventurous raids into the interior, making excursions also against the remote Indian tribes with a view to obtaining slaves, and from the year 1629 onwards repeatedly attacked the Indian reductions of the Jesuits in Paraguay, although both provinces were then nominally subject to the crown of Spain. Other bands penetrated into Minas and still farther north and westward, discovering mines there and in Goyaz and Cuyabá. New colonies were thus formed round those districts in which gold had been found, and in the beginning of the 18th century five principal settlements in Minas Geraes had been elevated by royal charter to the privileges of towns. In 1720 this district was separated from São Paulo, to which it had previously been dependent. As early as 1618 a code of laws for the regulation of the mining industry had been drawn up by Philip III., the executive and judicial functions in the mining districts being vested in a *provedor*, and the fiscal in a treasurer, who received the royal fifths and superintended the weighing of all the gold, rendering a yearly account of all discoveries and produce. For many years, however, these laws were little more than a dead letter. The same infatuated passion for mining speculation which had characterized the Spanish settlers in South America now began to actuate the Portuguese; labourers and capital were drained off to the mining districts, and Brazil, which had hitherto in great measure supplied Europe with sugar, sank before the competition of the English and French. A new source of wealth was now opened up; some adventurers from Villa do Principe in Minas, going north to the Seria Frio, made the discovery of diamonds about the year 1710, but it was not till 1730 that the discovery was for the first time announced to the Government, which immediately declared them *regalia*. While the population of Brazil continued to increase, the moral and intellectual culture of its inhabitants was left in great measure to chance; they grew up with those robust and healthy sentiments which are engendered by the absence of false teachers, but with a repugnance to legal ordinances, and encouraged in their ascendency over the Indians to habits of violence and oppression. The Jesuits from the first moment of their landing in Brazil had constituted themselves the protectors of the natives, and though strenuously opposed by the colonists and ordinary clergy, had gathered the Indians together in many *aldeas*, over which officials of their order exercised spiritual and temporal authority. A more efficacious stop, however, was put to the persecution of the Indians by the importation of large numbers of negroes from the Portuguese possessions in Africa, these being found more active and serviceable than the native tribes.

The Portuguese Government, under the administration of Carvalho, afterwards marquis of Pombal, attempted to extend to Brazil the bold spirit of innovation which directed all his efforts. The proud minister had been resisted in his plans of reform at home by the Jesuits, and, determining to attack the power of the order, first deprived them of all temporal power in the state of Maranhão and Pará. These ordinances soon spread to the whole of Brazil, and a pretext being found in the suspicion of Jesuit influence in some partial revolts of the Indian troops on the Rio Negro, the order was expelled from Brazil under circumstances of great severity in 1760. The Brazilian Company founded by Vieyra, which so materially contributed to preserve its South American possessions to Portugal, had been abolished in 1721 by João V.; but such an instrument being well suited to the bold spirit of Pombal, he established a chartered company again in 1755, to trade exclusively with Maranhão and Pará; and in 1759, in spite of the remonstrance of the British Factory at Lisbon, formed another company for Paraiba and Pernambuco. Pombal's arrangements extended also to the interior of the country, where he extinguished at once the now indefinite and oppressive claims of the original donatories of the captaincies, and strengthened and enforced the regulations of the mining districts. The policy of many of Pombal's measures is more than questionable; but his admission of all races to equal rights in the eye of the law, his abolition of feudal privileges, and the firmer organization of the powers of the land which he introduced, powerfully co-operated towards the development of the capabilities of Brazil. Yet on the death of his king and patron in 1777, when court intrigue forced him from his high station, he who had done so much for his country's institutions was reviled on all hands.

The most important feature in the history of Brazil during the first thirty years following the retirement of Pombal was the conspiracy of Minas in 1789. The successful issue of the recent revolution of the English colonies in North America had filled the minds of some of the more educated youth of that province; and in imitation, a project to throw off the Portuguese yoke was formed,—a cavalry officer, Silva Xavier, nicknamed Tira-dentes (tooth-drawer), being the chief conspirator. But the plot being discovered during their inactivity, the conspirators were banished to Africa, and Tira-dentes, the leader, was hanged. Thenceforward affairs went on prosperously; the mining districts continued to be enlarged; the trading companies of the littoral provinces were abolished, but the impulse they had given to agriculture remained.

Removed from all communication with the rest of the world except through the mother country, Brazil remained unaffected by the first years of the great revolutionary war in Europe. Indirectly, however, the fate of this isolated country was decided by the consequences of the French Revolution. Brazil is the only instance of a colony becoming the seat of the Government of its own mother country, and this was the work of Napoleon. When he resolved upon the invasion and conquest of Portugal, the Prince Regent, afterwards Dom João VI., having no means of resistance, decided to take refuge in Brazil. He created a regency in Lisbon, and departed for Brazil on the 29th November 1807, accompanied by the Queen Donna Maria I., the royal family, all the great officers of state, a large part of the nobility, and numerous retainers. They arrived at Bahia on the 21st January 1808, and were received with enthusiasm. The regent was requested to establish there the seat of his government, but a more secure asylum presented itself in Rio de Janeiro, where the royal fugitives arrived on the 7th of March. Before leaving Bahia Don John took the first step to emancipate Brazil, opening its ports to foreign commerce, and permitting the export of all Brazilian produce under any flag, the royal monopolies of diamonds and Brazil-wood excepted. Once established in Rio de Janeiro, the government of the regent was directed to the creation of an administrative machinery for the dominions that remained to him as they existed in Portugal. Besides the ministry which had come with the regent, the council of state, and the departments of the four ministries of home, finances, war, and marine then existing, there were created in the course of one year a supreme court of justice, a board of patronage and administration of the property of the church and military orders, an inferior court of appeal, the court of exchequer and royal treasury, the royal mint, bank of Brazil, royal printing-office, powder-mills on a large scale, and a supreme military court. The maintenance of the court, and the salaries of so large a number of high officials, entailed the

imposition of new taxes to meet these expenses. Notwithstanding this the expenses continued to augment, and the Government had recourse to the reprehensible measure of altering the money standard, and the whole monetary system was soon thrown into the greatest confusion, a state of things from which the country suffers even at the present day. The bank, in addition to its private functions, farmed many of the *regalia*, and was in the practice of advancing large sums to the state, transactions which gave rise to extensive corruption, and terminated some years later in the breaking of the bank.

Thus the Government of the prince regent began its career in the new world with dangerous errors in the financial system; yet the increased activity which a multitude of new customers and the increase of circulating medium gave to the trade of Rio, added a new stimulus to the industry of the whole nation. Numbers of English artisans and shipbuilders, Swedish iron-founders, German engineers, and French manufacturers sought fortunes in the new country, and diffused industry by their example.

In the beginning of 1809, in retaliation of the occupation of Portugal, an expedition was sent from Pará to the French colony of Guiana, and after some fighting this part of Guiana was incorporated with Brazil. This conquest was, however, of short duration; for, by the treaty of Vienna in 1815, the colony was restored to France. Its occupation contributed to the improvement of agriculture in Brazil; it had been the policy of Portugal up to this time to separate the productions of its colonies, to reserve sugar for Brazil, and spices to the East Indies, and to prohibit the cultivation of these in the African possessions. Now, however, many plants were imported not only from Guiana but from India and Africa, cultivated in the Royal Botanic Garden, and thence distributed. The same principle which dictated the conquest of French Guiana originated attempts to seize the Spanish colonies of Monte Video and Buenos Ayres, Portugal being also at war with Spain. The chiefs of these colonies were invited to place them under the protection of the Portuguese crown, but these at first affecting loyalty to Spain declined the offer, then threw off the mask and declared themselves independent, and the Spanish governor, Elio, was afterwards defeated by Artigas, the leader of the independents.

The inroads made on the frontiers of Rio Grande and São Paulo decided the court of Rio to take possession of Monte Video; a force of 5000 troops was sent thither from Portugal, together with a Brazilian corps; and the irregulars of Artigas, unable to withstand disciplined troops, were forced, after a total defeat, to take refuge beyond the River Uruguay. The Portuguese took possession of the city of Monte Video in January 1817, and the territory of Missiones was afterwards occupied. The importance which Brazil was acquiring decided the regent to give it the title of kingdom, and by decree of the 16th January 1815, the Portuguese sovereignty thenceforward took the title of the United Kingdom of Portugal, Brazil, and Algarves. Thus the old colonial government disappeared even in name. In March 1816 the Queen Donna Maria I. died, and the prince regent became king under the title of Dom João VI.

Although Brazil had now become in fact the head of its own mother country, the government was not in the hands of Brazilians, but of the Portuguese, who had followed the court. The discontent arising among Brazilians from this cause was heightened by a decree assigning a heavy tax on the chief Brazilian custom houses, to be in operation for forty years, for the benefit of the Portuguese noblemen who had suffered during the war with France. The amiable character of the king preserved his own popularity, but the Government was ignorant and profligate, justice was ill administered, negligence and disorder reigned in all its departments. Nor was the discontent less in Portugal on account of its anomalous position. These causes and the fermentation of liberal principles produced by the French Revolution originated a conspiracy in Lisbon in 1817, which was, however, discovered in time to prevent its success. A similar plot and rebellion took place in the province of Pernambuco, where the inhabitants of the important commercial city of Recife were jealous of Rio and the sacrifices they were compelled to make for the support of the luxurious court there. Another conspiracy to establish a republican government was promptly smothered in Bahia, and the outbreak in Pernambuco was put down after a republic had been formed there for ninety days. Still the progress of the republican spirit in Brazil caused Dom João to send to Portugal for bodies of picked troops, which were stationed throughout the provincial capitals. In Portugal the popular discontent produced the revolution of 1820, when representative government was proclaimed—the Spanish constitution of 1812 being provisionally adopted. In Rio, the Portuguese troops with which the king had surrounded himself as a defence against the liberal spirit of the Brazilians, took up arms on the 26th February 1821, to force him to accept the system proclaimed in Portugal. The prince Dom Pedro, heir to the crown, who now for the first time took part in public affairs, actively exerted himself as a negotiator between the king and the troops, who were joined by bodies of the people. After attempting a compromise the king finally submitted, took the oath, and named a new ministry. The idea of free government filled the people with enthusiasm, and the principles of a representative legislature were freely adopted, the first care being for the election of deputies to the *Cortes* of Lisbon to take part in framing the new constitution. As the king could not abandon Portugal to itself he determined at first to send the prince thither as regent, but Dom Pedro had acquired such popularity by his conduct in the revolution, and had exhibited such a thirst for glory, that the king feared to trust his adventurous spirit in Europe, and decided to go himself. The Brazilian deputies on arriving in Lisbon expressed dissatisfaction with the Cortes for having begun the framing of the constitution before their arrival, for Brazil could not be treated as a secondary part of the monarchy. Sharp discussions and angry words passed between the Brazilian and Portuguese deputies, the news of which excited great discontent in Brazil. An insulting decree was passed in the Cortes, ordering the prince Dom Pedro to come to Europe, which filled the Brazilians with alarm; they foresaw that without a central authority the country would fall back to its former colonial state subject to Portugal. The Provisional Government of São Paulo, influenced by the brothers Andradas, began a movement for independence by asking the prince to disobey the Cortes and remain in Brazil, and the council of Rio de Janeiro followed with a similar representation, to which the prince assented. The Portuguese troops of the capital at first assumed a coercive attitude, but were forced to give way before the ardour and military preparations of the Brazilians, and submitted to embark for Portugal. These scenes were repeated in Pernambuco, where the Portuguese, after various conflicts, were obliged to leave the country; in Bahia, however, as well as in Maranhão and Pará, the Portuguese prevailed. In Rio the agitation for independence continued. The two brothers Andradas were called to the ministry; and the municipal council conferred upon the prince regent the title of Perpetual-Defender of Brazil. With great activity he set off to the central provinces of Minas and São Paulo to suppress disaffected movements and direct the revolution. In São Paulo, on the 7th of September 1822, he proclaimed the independence of Brazil. On his return to Rio de

Janeiro on the 12th of October he was proclaimed constitutional emperor with great enthusiasm.

The Cortes at Lisbon chose Bahia as a centre for resisting the independence, and large forces were sent thither. But the city was vigorously besieged by the Brazilians by land, and finally the Portuguese were obliged to re-embark on the 2d of July 1823. A Brazilian squadron, under command of Lord Cochrane, attacked the Portuguese vessels, embarrassed with troops, and took several of them. Taylor, another Englishman in Brazilian service, followed the vessels across the Atlantic, and even captured some of the ships in sight of the land of Portugal. The troops in Monte Video also embarked for Portugal, and the Banda Oriental remained a part of Brazil with the title of the *Provincia Cisplatina*. Before the end of 1823 the authority of the new emperor and the independence of Brazil were undisputed throughout the whole country.

Republican movements now began to spread, to suppress which the authorities made use of the Portuguese remaining in the country; and the disposition of the emperor to consider these as his firmest supporters much influenced the course of his Government and his future destiny. The two Andradas, who imagined they could govern the young emperor as a sovereign of their own creation, encountered great opposition in the constitutional assembly, which had been opened in Rio in May 1823, to discuss the project of a new constitution. In July the emperor resolved to dismiss them and form a new ministry, but against this the brothers raised a violent opposition. In November the emperor put an end to the angry debates which ensued in the assembly by dissolving it, exiling the Andradas to France, and convoking a new assembly to deliberate on a proposed constitution more liberal than the former project. The proclamation of a republic in the provinces of Pernambuco and Ceará, with the rebellion of the Cisplatina province, favoured by Buenos Ayres and its ultimate loss to Brazil, were the result of the *coup d'état* of November 1823. The Brazilians were universally discontented,—on one side fearing absolutism if they supported the emperor, on the other anarchy if he fell. Knowing the danger of an undefined position, the emperor caused the councils to dispense with their deliberations, and adopt, as the constitution of the empire, the project framed by the council of state. Accordingly, on March 25, 1824, the emperor swore to the constitution with great solemnity and public rejoicings. By this stroke of policy he saved himself and Brazil. Negotiations were opened in London between the Brazilian and Portuguese plenipotentiaries, treating for the recognition of the independence of Brazil; and on the 25th of August 1825 a treaty was signed by which the Portuguese king, Dom João VI., assumed the title of Emperor of Brazil, and immediately abdicated in favour of his son, acknowledging Brazil as an independent empire, but the treaty obliged Brazil to take upon herself the Portuguese debt, amounting to nearly two millions sterling.

The rebellion of the Banda Oriental was followed by a declaration of war with Buenos Ayres which had supported it, and operations by sea and land were conducted against that republic in a feeble way. Meanwhile the well-deserved popularity of the emperor began to decline. He had given himself up to the influence of the Portuguese; the most popular men who had worked for the independence were banished; and a continual change of ministry showed a disposition on the part of the sovereign to prosecute obstinately measures of which his advisers disapproved. His popularity was regained, however, to some extent, when, on the death of his father, he was unanimously acknowledged king of Portugal, and especially when he abdicated that crown in favour of his daughter, Donna Maria; but his line of policy was not altered, and commercial treaties entered into with European states conceding them favours, which were popularly considered to be injurious to Brazilian trade, met with bitter censure.

During the year 1827 the public debt was consolidated, and a department was created for the application of a sinking fund.

The year 1828 was a calamitous one for Brazil. It began with the defeat of the Brazilian army by the Argentine forces, and this entirely through the incapacity of the commander-in-chief; and misunderstandings, afterwards compensated by humbling money-payments on the part of Brazil, arose with the United States, France, and England, on account of merchant vessels captured by the Brazilian squadron blockading Buenos Ayres. Financial embarrassments increased to an alarming extent; the emperor was compelled by the British Government to make peace with Buenos Ayres and to renounce the Banda Oriental; and to fill the sum of disasters Don Miguel had treacherously usurped the crown of Portugal. It was under these unlucky auspices that the elections of new deputies took place in 1829. As was expected the result was the election everywhere of ultra-liberals opposed to the emperor, and in the succeeding year people everywhere exhibited their disaffection. During the session of 1830 the chambers adopted a criminal code in which punishment by death for political offences was abolished. It was openly suggested in the journals to reform the constitution by turning Brazil into independent federal provinces, governed by authorities popularly elected, as in the United States. Alarmed at length at the ground gained by this idea in the provinces, the emperor set off to Minas to stir up the former enthusiasm in his favour from recollections of the independence, but was coldly received. On his return to Rio in March 1831 scenes of disorder occurred, and great agitation among the Liberal party. Imagining himself sure of a brilliant destiny in Europe if he lost his Brazilian crown, the emperor attempted to risk a decisive attack against the Liberals, and to form a new ministry composed of men favourable to absolutism. This step caused excited public meetings in the capital, which were joined in by the troops, and deputations went to ask the emperor to dismiss the unpopular ministry. He replied by dissolving the ministry without naming another, and by abdicating the crown in favour of the heir apparent, then only five years of age. Dom Pedro immediately embarked in an English ship, leaving the new Emperor Dom Pedro II. and the princesses Januaria, Francisca, and Paula. The subsequent career of this unfortunate prince belongs to the history of Portugal.

A provisional and afterwards a permanent regency, composed of three members, was now formed in Brazil, but scenes of disorder succeeded, and discussions and struggles between the republican party and the Government, and a reactionary third party in favour of the restoration of Dom Pedro, occupied the succeeding years. In 1834 a reform which was well received consisted in the alteration of the regency, from that of three members elected by the legislative chambers, to one regent chosen by the whole of the electors in the same manner as the deputies; and the councils of the provinces were replaced by legislative provincial assemblies. Virtually, this was a republican government like that of the United States, for no difference existed in the mode of election of the regent from that of a president. The ex-minister Feijoó was chosen for this office. With the exception of Pará and Rio Grande the provinces were at peace, but these were in open rebellion; the former was reduced to obedience, but in the latter, though the imperial troops occupied the town, the country

was ravaged by its warlike inhabitants. The regent was now accused of conniving at this rebellion, and the opposition of the Chamber of Deputies became so violent as to necessitate his resignation. Araujo Lima, minister of the home department, who strove to give his government the character of a monarchical reaction against the principles of democracy, was chosen by a large majority in his stead. The experiment of republican government had proved so discreditable, and had so wearied the country of cabals, that men hitherto known for their sympathy with democratic principles became more monarchical than the regent himself; and under this influence a movement to give the regency into the hands of the Princess Donna Januaria, now in her 18th year, was set on foot. It was soon perceived, however, that if the empire could be governed by a princess of eighteen it could be managed better by the emperor himself, who was then fourteen.

A bill was accordingly presented to legislature dispensing with the age of the emperor and declaring his majority, which after a noisy discussion was carried. The majority of the Emperor Dom Pedro II. was proclaimed on the 23d July 1840. Several ministries, in which various parties predominated for a time, now governed the country till 1848, during which period the rebellious province of Rio Grande was pacified, more by negotiation than force of arms. In 1848 hostilities were roused with the British Government through the neglect shown by the Brazilians in putting in force a treaty for the abolition of the slave trade, which had been concluded as far back as 1826; on the other hand the governor of Buenos Ayres, General Rosas, was endeavouring to stir up revolution again in Rio Grande. The appearance of yellow fever in 1849, until then unknown in Brazil, was attributed to the importation of slaves. Public opinion declared against the traffic; severe laws were passed against it, and were so firmly enforced that in 1853 not a single disembarkation took place. The ministry of the Visconde de Olinda in 1849 entered into alliances with the governors of Monte Video, Paraguay, and the states of Entre Rios and Corrientes, for the purpose of maintaining the integrity of the republics of Uruguay and Paraguay, which Rosas intended to re-unite to Buenos Ayres, and the troops of Rosas which besieged Monte Video were forced to capitulate. Rosas then declared war formally against Brazil. An army of Correntine, Uruguayan, and Brazilian troops, under General Urquiza, assisted by a Brazilian naval squadron, advanced on Buenos Ayres, completely routed the forces of Rosas, and crushed for ever the power of that dictator. From 1844 Brazil was free from intestine commotions, and had resumed its activity. Public works and education were advanced, and the finances rose to a degree of prosperity previously unknown.

In 1855 the emperor of Brazil sent a squadron of eleven men-of-war and as many transports up the Paraná to adjust several questions pending between the empire and the Republic of Paraguay, the most important of which was that of the right of way by the Paraguay River to the interior Brazilian province of Matto Grosso. This right had been in dispute for several years. The expedition was not permitted to ascend the River Paraguay, and returned completely foiled in its main purpose. Though the discord resulting between the states on account of this failure was subsequently allayed for a time by a treaty granting to Brazil the right to navigate the river, every obstacle was thrown in the way by the Paraguayan Government, and indignities of all kinds were offered not only to Brazil but to the representatives of the Argentine and the United States. In 1864 the ambitious dictator of Paraguay, Francisco Solano Lopez, without previous declaration of war, captured a Brazilian vessel in the Paraguay, and rapidly followed up this outrage by an armed invasion of the provinces of Matto Grosso and Rio Grande in Brazil, and that of Corrientes in the Argentine Republic. A triple alliance of the invaded states with Uruguay ensued, and the tide of war was soon turned from being an offensive one on the part of Paraguay to a defensive struggle within that republic against the superior number of the allies. So strong was the natural position of Paraguay, however, and so complete the subjection of its inhabitants to the will of the dictator, that it was not until the year 1870, after the republic had been completely drained of its manhood and resources, that the long war was terminated by the capture and death of Lopez with his last handful of men by the pursuing Brazilians. From its duration and frequent battles and sieges this war involved an immense sacrifice of life to Brazil, the army in the field having been constantly maintained at between 20,000 and 30,000 men, and the expenditure in maintaining it was very great, having been calculated at upwards of fifty millions sterling. Large deficits in the financial budgets of the state resulted, involving increased taxation and the contracting of loans from foreign countries.

Notwithstanding this the sources of public wealth in Brazil were unaffected, and commerce continued steadily to increase. A grand social reform was effected in the law passed in September 1871, which enacted that from that date every child born of slave parents should be free, and also declared all the slaves belonging to the state or to the imperial household free from that time. The same law provided an emancipation fund, to be annually applied to the ransom of a certain number of slaves owned by private individuals. Since that time the emancipation of slaves has gone on rapidly, the work having been promoted largely by the slave owners and by private philanthropy. It is estimated that since the cessation of the importing of slaves in 1853, and especially after the enactment of 1871, not less than a million of slaves have obtained their freedom; and the total extinction of slavery within the empire is not far distant. From the extremely rapid progress of this movement difficulties have been experienced in a considerable degree in procuring a sufficient supply of labour for the Brazilian plantations, but the general effect of the law has been to give new directions to the employment of capital, and the construction of railroads and telegraphs, and the improvement of internal communication by roads and rivers have been largely promoted. Attention has also been strongly directed towards the further development of the provinces by the increase of European immigration. Enterprises of all kinds have multiplied, and public instruction has received a vigorous impulse.

The Emperor Dom Pedro II. and the empress, a sister of the king of Naples, are universally beloved and respected for their intellectual and moral endowments, and their affectionate interest in the welfare of their subjects. Princess Isabel, born in July 1846, and her son born in October 1875, are their only surviving offspring.

Until after the year 1872, when a complete census of the empire was begun, every estimate of the population of Brazil was based upon the official returns of 1817–18, and these have consequently been mere approximations, varying very considerably in the hands of different authors. In the first census referred to the whole number of people was 4,396,000, including an estimated number of 800,000 Indians; in 1850 the total was reckoned roundly at 7,000,000; and in 1860 at 8,000,000.

In the following table the results of the census of 1872 have been incorporated, as far as these have yet been published, the remaining figures being made up from the estimates formerly given for each of the provinces. The

table also contains the area of each of the provinces, from planimetric calculations made in Gotha in 1872, the official returns on this subject being most obviously exaggerated, and claiming for the empire an area equal to that of Brazil with all the surrounding republics on the north and west taken together.

Provinces.	Area in English Square Miles.	Population.			Chief Towns.
		Free.	Slave.	Total.	
Alto Amazonas	753,469	56,631	979	57,610*	Manáos.
Grão Pará	412,467	232,622	27,199	259,821	Pará or Belem.
Maranhão	141,651	284,101	74,939	359,040	S. Luiz do Maranhão.
Piauhy	81,779	178,427	23,785	202,222	Therezina.
Ceará	50,262	689,773	31,913	721,686*	Fortaleza.
Rio Grande do Norte	20,130	220,959	13,020	233,979	Natal.
Parahyba	20,346	341,643	20,914	362,557	Parahyba.
Pernambuco	46,257	752,511	89,028	841,539*	Recife.
Alagôas	11,642	312,268	35,741	348,009*	Macelo.
Sergipe	12,038	139,812	21,495	161,307	Aracajú.
Bahia	204,803	1,120,846	162,295	1,283,141	Bahia.
Espiritu Santo	17,030	59,478	22,659	82,137*	Victoria.
Rio de Janeiro	18,490	456,850	270,726	727,576	Rio de Janeiro.
Neut. Municipty.		226,033	48,939	274,972*	
São Paulo	90,541	680,742	156,612	837,354*	São Paulo.
Paraná	108,557	116,162	10,560	126,722*	Curitiba.
Sta. Catharina	18,924	144,818	14,984	159,802	Desterro.
Rio Grande do Sul	110,216	364,002	66,876	430,878	Porto-Alegre.
Minas Geraes	237,481	1,642,449	366,574	2,009,023	Ouro Preto.
Goyaz	263,373	149,743	10,652	160,395*	Goyaz.
Matto Grosso	668,655	53,758	6,667	60,417*	Cuyabá.
	3,288,110	8,223,620	1,476,567	9,700,187	

* The population figures marked thus are the results of the census begun in 1872; the others are made up from the most recent provincial estimates.

Races. The population of Brazil presents a number of distinct types as well as many varieties blended from these. The aboriginal Indians of the country have to a large extent become amalgamated with the settled population, especially in the eastern or maritime provinces; but in the vast forests and grass plains of the interior they remain in a more or less completely savage condition. In general description the Indians are of copper colour, of middle height, thick-set, broad-chested, and muscular, with well-shaped limbs and small hands and feet. The hair is black, thick, and straight; the features broad, cheek bones not generally prominent, eyes black and sometimes oblique, like those of the Tatar races of Eastern Asia; they are of apathetic and undemonstrative nature. Their tribes and subdivisions, scattered over the enormous interior area, are countless; though these may vary somewhat in physical characteristics, in language, and customs, they belong apparently to one original stock, called by ethnographers, the Tupi-Guarani. Most of the semi-civilized Indians of Brazil, especially those of the eastern provinces, speak the Lingoa-Geral, a language adapted by the Jesuit missionaries from the original idiom of the Tupinambaras, one of the larger eastern tribes. The less civilized and savage Indians are termed collectively Gentios (heathens) by the Brazilians. The only tribe of the eastern coast-lands which has resisted civilization in some portion of its numbers is that of the Botocudos, inhabiting the forests between the Rio Doce and Rio Pardo, sunk in the lowest barbarism and fast disappearing. From the European—chiefly Portuguese—immigrants, by mixture with the native Indians, are descended the Mamelucos, a variety which first made itself prominent in inland raids and conquests in the southern provinces, especially from the neighbourhood of São Paulo, whence they were named Paulistas. The negroes, introduced from Africa in immense numbers, constitute one of the largest elements of population. From these, by intercourse with the white race, have sprung the mulattoes, and the descendants of these, becoming progressively whiter. The Brazilian creoles, who call themselves Brazileiros, descendants of these mixed races, prove little inferior in capacity, physical strength, or intelligence to the pure race of Portuguese. The rapidly progressing emancipation of the African slaves in Brazil has been referred to previously. A strong desire pervades those of the slaves not born in Brazil, even though they may have been made captives when mere infants, to return to Africa. Associations have been formed among them in many parts, both for the purchase of the freedom of those still in bondage and for sending the freedmen back to their native country, a movement which has actually taken place to a considerable extent. A result of the emancipation and consequent deficiency of labour, chiefly felt in the neighbourhood of Rio and the provinces to the south of it, has been the deportation of large numbers of slaves from the northern to the more southerly provinces.

An increase in the population of Brazil being one of the prime requisites for the advancement of the country, the state encourages immigration by every possible means, and especially of late years, since the labour question began to be serious, has made great efforts to entice European colonists. For this end an official agency was established at Rio de Janeiro in 1864, to provide for the conveyance and landing of colonists and for forwarding these to the various localities. The passage from whatever country to Brazil, and thence to the special colony inland, is also defrayed by Government, and other advantages are held out. Notwithstanding the zeal with which the many schemes of state or private colonization in Brazil have been promoted, the results have been far from satisfactory; as far as British, German, and Swiss experience goes these have been in many instances very disastrous; and whatever seductive representation of advantages may be held out, any scheme for the introduction of north European colonists into Brazil cannot be too strongly deprecated. Not only is the climate and soil, except perhaps of the extreme southern province, unsuited to the Anglo-Saxon race, but the abandonment of nationality and of language, of customs and laws, and the obnoxious surroundings, prove fatal to success. Colon

The chief state colonies are at the following places. *Santa Leopoldina*, thirty-three miles distant from the capital of the province of Espiritu-Santo, having free access to it by the Sta. Maria River,—is chiefly a German, Swiss, and Dutch colony. *Rio Novo* is in the same province. *Mucury*, in the province of Minas Geraes, is also a German colony. *Canarea* in the province of São Paulo, 14 miles from the sea-coast and near the town of the same name, is mainly English. *Assungay*, 62 miles from the capital of the province of Paraná, *Itajahy*, 29 miles from the port of the same name in the province of Sta. Catharina, and *Blumenau*, also in that province on the navigable River Itajahy, are chiefly German. *Sta. Maria de Soledade*, near São Leopoldo, in Rio Grande do Sul, is also a state colony. Several places long colonized have passed out of the colonial régime, and have been formed into municipalities. Such are *São Leopoldo* in Rio Grande, *Santa Isabel* in the province of Sta. Catharina, *Nova Friburgo* and *Petropolis* in elevated districts of the Organ Mountains in Rio de Janeiro.

Private and provincial colonies are rather numerous. Of these there are eight in Rio Grande do Sul, the chief being that of *Sta Cruz*; Sta Catharina has two; Minas Geraes and Bahia, each one. Taken together the state, provincial, and private colonies embraced, in 1873, upwards of 40,000 people. During the past two years the unsettled condition and financial difficulties of the La Plata states have thrown large numbers of foreign—chiefly Italian—settlers into destitution, and many hundreds of these have been induced, by the offer of free passage and land, to seek a new home in Brazil.

The Brazilian monarchy derives from the ancient monarchy of Portugal the principle of hereditary succession to

the crown. The laws of succession are defined with great distinctness in the constitution, and are the same as in England.

In Brazil there is no privileged aristocracy, but descent from the noble families of Portugal, length of time in the service of the country, or large fortune, gives a certain claim to the privileges of aristocracy readily admitted by the Brazilians. The emperor rewards services, according to their difficulty or importance, with the titles of marquis, count, baron, or knight (moços fidalgos). Titles are not hereditary, but if a son prove himself worthy of his father, he inherits his title. There are in the empire six orders of chivalry; those of the Southern Cross, the order of Dom Pedro I., and of the Rose, created by the first emperor between 1822 and 1829; and those of Christ, St Benoit of Aviz, and St Theodoric, adopted by Dom Pedro II. The senate represents the only element of aristocracy recognized by the constitution, and the democratic element preponderates, but its action is modified by the complicated system of election. The constitution established four powers,—the moderating, the legislative, the executive, and the judicial.

The *moderating* power is vested exclusively in the emperor as chief representative of the nation, that he may maintain the equilibrium and harmony of the other powers. He exercises this function with regard to the legislature by being empowered to choose the senators, to convoke or adjourn the general assembly, to dissolve the chamber of deputies, and to sanction the decrees of the assembly; as regards the executive, by appointing or dismissing at will the ministers of state; and over the judicial power, by suspending the magistrates, pardoning or commuting penalties, and granting amnesties. The person of the emperor is sacred, inviolable, and irresponsible.

The *legislative* power is vested, for the affairs of the empire, in the general legislative assembly with the sanction of the emperor, and for the provincial affairs in the provincial assemblies with the sanction of the president (governor) of the province. The general legislative assembly consists of two chambers, that of deputies and that of senators. The deputies are nominated by indirect election. Citizens, and even manumitted slaves, born in the empire, who possess an income of £22, 10s., choose the electors in parochial assemblies, and these electors nominate the deputies. The qualification for an elector is an annual income of £45; that of a deputy an income of £90. Minors, monks, and servants, are debarred from voting; naturalized foreigners, and persons not professing the religion of the state, are incapable of being elected deputies, but they can be senators. The deputies to the number of 122 are elected for four years, and must hold an annual session of four months, opening on the 3d of May. The senators (58 in number) are elected for life. Every province has a number of senators, equal to half its number of deputies; but they are nominated in triple lists, from which the emperor selects one-third. A senator must be forty years of age, and must possess a clear annual income of £180. The allowance of a senator is one-half more than that of a deputy. Each house nominates its own officers. When the two houses sit in general assembly, as at the opening and close of the session, to hear the emperor's speech, &c., the president of the senate presides, and the senators and deputies sit promiscuously. They sit apart and proceed by way of bill, when they make laws, interpret, and suspend them; they determine the public charges, and assess the contributions, &c. The chamber of deputies has the initiative in taxes, in recruiting, and in the choice of a new dynasty. The senate has the exclusive privilege of taking cognizance of offences committed by members of the imperial family, councillors of state, senators, and deputies, during the session; of enforcing the responsibility of secretaries and councillors of state; of convoking the assembly in case the emperor fail to do so within two months after the period fixed by law; and also of calling it together on the death of the emperor.

The *executive* power is vested in the emperor, assisted by his ministers and secretaries of state, who are responsible for treason, corruption, abuse of power, acts contrary to the liberty, security, or property of the citizens, and waste of public property. From this responsibility they cannot escape upon the plea of orders from the emperor. The executive functions are such as the convocation of the general ordinary assembly; the nomination of bishops, presidents, governors of provinces; commanders by sea and land, and ambassadors; the formation of alliances, and all foreign negotiations; the declaration of peace and war; and the granting letters of naturalization.

The ministers are seven, one for each of the departments of the empire and ecclesiastical affairs; justice; war; marine; finances; foreign affairs; and agriculture, commerce, and public works. One of these is president or premier. To these is superadded a council of state composed of twelve ordinary members, besides which it may have as many as twelve extraordinary members, all of them appointed for life. The council is divided into sections corresponding to the seven ministries, or sits in full meeting, presided over by the emperor. The prince or princess imperial, on attaining the age of eighteen, has a seat in this assembly. The council is merely consultative, and though its use is optional it is always heard on any important public question or appeal to the crown. The provincial governments are entrusted to a president in each, appointed by the executive power and immediately under its control: he is the supreme representative of government in the province, sanctions the resolutions of the provincial assemblies, and appoints provincial functionaries. The provincial assemblies, elected every two years by the same citizens who elect members of the chamber of deputies, deal only with matters immediately relating to the private or local interests of the province.

Every city, town, and village, with the surrounding district, has a municipal council composed of nine or seven members, elected directly by the citizens who possess an annual income of £22, 10s. This council is charged with all that concerns the good of the district, meets four times a year, besides extraordinary sessions, and every meeting may last as many days as may be found necessary for the expedition of business. They impose fines to a certain amount, and even enforce their decrees by a penalty of thirty days' imprisonment. They annually draw up a municipal budget, which is submitted to the provincial legislative assembly for approval. If their revenue and the produce of fines be not sufficient to defray expenses, an allowance from the provincial treasury is granted. Their decrees are called *posturas*, and the penalties imposed by them are enforced by the justices of peace. Their enactments can be annulled by the provincial legislative assembly.

The *judicial* power is independent; the judges hold their offices for life, and cannot lose them except by a condemnatory sentence. They are, however, responsible for any abuse of authority, and may be summoned before a supreme court of judicial ministers. In criminal cases all proceedings are public after the indictment. In civil cases arbitrators may be appointed, whose decisions are without appeal, and no civil lawsuit can be carried on without previous declaration that conciliatory means were tried in vain.

The constitution guarantees the inviolability of the liberty, safety, and property of Brazilian citizens, and of their civil

and political rights. Individual liberty is subject only to law, and in the same way liberty of thought and of the press are guaranteed. No one may be persecuted on account of religious belief, and every kind of labour or industry is free which does not interfere with public well-being. No one can be arrested without written orders from lawful authority.

litical d other isions.

For purposes of election the empire is divided into *districts*, each of which elects a fixed number of deputies for the general and provincial assemblies. These are again divided into colleges and parish assemblies. There are 46 electoral districts, 408 colleges, and 1451 parish assemblies. For administrative purposes the Brazilian territory is separated into 20 *provinces*, comprising 642 municipalities, including that of the capital; from various causes the number of municipalities is fluctuating. The ecclesiastical jurisdiction is exercised in 12 *dioceses*, one of which, that of São Salvador, comprehending the province of Bahia and Sergipe, is a metropolitan archbishopric. The whole of the dioceses are divided into 1473 parishes and 28 curacies. The diocese of São Salvador is the seat of a metropolitan court of appeal (Relaçao), composed of judges of appeal (*desembargadores*), who decide clerical matters finally. The diocese of São Sebastião comprises the municipality of Rio de Janeiro, its province, those of Espiritu Santo and Sta. Catharina, and the eastern side of Minas Geraes. The provinces of Alagôas, Pernambuco, Parahyba, and Rio Grande do Norte form the bishopric of Olinda; Maranhão and Piauhy the bishopric of the former name; Pará and Amazonas the diocese of Belem do Pará. The diocese of São Paulo includes that province, Paraná, and southern Minas Geraes; that of Goyaz its province and western Minas; the remainder of Minas forms the bishoprics of Marianna in the central, and of Diamantina in the northern part of the province. The diocese of Cuyabá consists of the province of Matto Grosso. The provinces of São Pedro do Rio Grande do Sul and of Ceará correspond to their respective bishoprics.

The judicial division of the empire is into eleven districts, each having a court of appeal competent to try all questions affecting the judges and military commanders. From the sentences of these courts there is but one appeal to a supreme court of justice, the members of which are denominated ministers, and by the constitution are counsellors to the emperor: this highest court takes cognizance of offences or errors committed by its ministers, by the judges of appeal, or by archbishops or bishops in non-ecclesiastical matters.

The districts of the Courts of Appeal are groups of provinces as follows:—

Pará and Amazonas	with the seat at	Belém.
Maranhão and Piauhy	,,	S. Luiz do Maranhão.
Ceará and Rio Grande do Norte......	,,	Fortaleza.
Pernambuco, Parahyba, and Alagoas	,,	Recife.
Bahia and Sergipe	,,	S. Salvador.
Rio and Espiritu Santo	,,	Rio de Janeiro.
S. Paulo and Paraná	,,	S. Paulo.
Rio Grande do Sul and Sta. Catharina	,,	Porto Alegre.
Minas Geraes	,,	Ouro Preto.
Matto Grosso	,,	Cuyabá.
Goyaz	,,	Goyaz.

Causes which do not ascend above a certain value, determined by law, are judged by *juizes de direito* within certain minor territorial limits, termed *comarcas*, again divided into *termos* or boroughs, which may include one or more municipalities, each of which has a municipal judge

The civil laws, originally the same with those of Portugal, have been greatly modified by a number of new ones A criminal code was organized in 1830 on the principles of Jeremy Bentham, and is considered very perfect and clear. The new form of procedure, and the new organization of justices, is embodied in a code decreed in 1832. Finally, a new code of commerce, nearly copied from that of France was decreed in 1850.

Finan

To carry on the war of the Independence, and to crush a subsequent revolution in the northern provinces, the Government contracted two loans in 1824–5, of the nominal amount of £3,686,200; and on the recognition of its independence by Portugal in 1825, it undertook the liability of a loan of £1,500,000. The war with Buenos Ayres, and the assistance rendered by Dom Pedro to the constitutional party of Portugal, led to two farther loans in 1829, of the nominal amount of £769,200. Internal difficulties in 1839 compelled the regency to contract another loan of the nominal amount of £411,200. The dissensions in Portugal caused a temporary suspension in the payment of the dividends on the Portuguese loan, and in 1842, £732,600 stock were delivered to the Portuguese agents in settlement of this claim. The debt contracted and assumed by Brazil between 1823 and 1843, therefore, amounted to £7,099,200 nominal; and throughout all its difficulties and embarrassments the Imperial Government punctually and honourably provided for the dividends as they became due.

By the renewal in 1844 of the sinking fund, the operation of which had been suspended since 1828, the Portuguese and other loans were becoming gradually reduced. The long war with Paraguay from 1864 to 1870, however, very considerably augmented the public debt, costing the empire more than 460,000 contos of reis, or nearly £52,000,000. The public debt is now divided into the consolidated foreign and internal debts, and the floating debt. The foreign debt proceeds from loans negotiated in the London Exchange in 1865, 1871, and 1875; the internal debt from policies authorized in 1827, but mainly from a home loan of 1868. The floating debt consists of the small remaining portion of that contracted previously to 1827, of loans borrowed from various internal sources, of exchequer bills, and paper money. Under these heads the debt of the empire was officially stated on the 31st of March 1875 as follows:—

External Debt	(at 5 per cent.	interest),	177,166 : 222	contos.
Internal	,,	,,	285,592 : 200	,,
Floating	,,	,,	201,980 : 973	,,
		Total Debt,	664,739 : 395=£74,783,000.	

(177,166 : 222=177,166 contos, 222 milreis; a conto or million of reis, gold=£112, 10s., or £1 = 8·890 milreis. 1 milreis=2s. 3d. The financial accounts are kept in *paper* reis, of depreciated value, in proportion varying from 194 to 214 reis paper to 100 reis gold.)

For a few years previously to the declaration of the emperor's majority, the imperial expenditure had not been largely in excess of the revenue, and in 1836–37, the deficit only amounted to £53,600; but in 1840–41, the year of the emperor's majority, it rose to £408,000, and in consequence of a revolution in Rio Grande do Sul it went on increasing till in 1845 it had reached nearly treble that sum. But before 1850 the deficiency had not only been made good, but a large surplus began to accumulate, which remained at about an annual sum of £400,000 after 1853. On the outbreak of the war in 1864, increased taxation was necessary to enable the exchequer to meet the extraordinary expenses, but on the close of the ministerial accounts for 1870–71, a surplus of upwards of £900,000 remained. In amount the revenues of the empire have progressively ascended from £1,380,000 in 1837 to upwards of £6,000,000.

The financial account of the year 1872–73, presented to the Chambers in May 1875, was as follows:—

Revenue.

Customs	£3,390,800
Taxes on Shipping	32,000
Export Duties	1,087,700
Railways	390,900
Posts	47,700
Telegraphs....................................	7,700
Stamps	227,000
Inland Taxes	756,000
Extraordinary receipts from bonds, issue of paper money, and deposits....	281,800
Carry forward	£6,221,600

Brought forward	£6,221,600
Fund for emancipation of slaves	86,200
Total state revenue 112,131 : 104 contos paper,[1] or	£6,307,800
Provincial receipts	1,210,000
Municipal receipts	256,000
Total (138,195 : 180 contos)	£7,773,800

Expenditure.

Home Department	£405,800
Justice	224,700
Foreign Affairs	58,900
Marine	1,006,600
War	1,358,300
Finances	2,375,000
Commerce	1,426,000
Total (121,874 : 462 contos)	£6,855,300

In the Budget for 1876–77 the receipts are estimated at 107,133 : 070 contos or £6,026,200 ; the expenditure at 105,378 : 914 contos or £5,927,800.

There are twenty-three custom houses, the amount of duties collected being largest in that of the capital, next in order those of Pernambuco, Bahia, and Pará.

The effective strength of the army and navy is every year fixed by the general legislative assembly, upon the data furnished by the ministers of the two departments. The army was originally organized on the principles established by Marshal Beresford when in the service of Portugal. It is principally from the northern provinces that the infantry is recruited, and from the southern that the best cavalry is obtained. A board, presided over by H. R. H. the Comte d'Eu, marshal of the army, is charged with the reformation of military legislation, and has been in session for some years. The actual army is thus composed, on a peace footing:—

a. Special corps, staff engineers and sanitary corps	427
b. Infantry, 21 battalions	9,864
c. Cavalry, 5 regiments and 2 battalions	2,484
d. Artillery, 3 regiments and 4 batteries, with 1 battalion of engineers	3,280
e. A division stationed in Paraguay, of various arms	1,894
	17,949

On a war footing the army is raised to 32,000 men.

Besides the regular army there is a national guard, which was organized in 1831, and comprised nearly 750,000 men in the latest returns, in cavalry, artillery, infantry, and reserve. This force has been disbanded for the present, to be re-organized on the completion of the census begun in 1872.

The police service of the empire is performed by city guards under military organization, under the provincial legislatures. The provinces of Pará, Pernambuco, Bahia, Rio Grande do Sul, and Matto Grosso possess military arsenals, recently reorganized. Military colonies for disciplinary or penitentiary objects, and also for protection of the frontiers, are dotted round the outskirts of the empire.

The navy is under the control of the minister of marine, assisted by a naval council instituted in 1855, organized after the plan of the French admiralty. There are six arsenals, and a pyrotechnical laboratory was established near Rio in 1868

The navy is principally manned by civilized aborigines and negroes, organized in bodies called imperial sailors, with a certain military discipline. The aborigines have a peculiar aptitude for a maritime life. Officers destined for the Brazilian navy receive a suitable education in the naval school of Rio, and for some years the Government introduced the practice of sending the more apt scholars to serve in the British, French, and American navies. In this way a body of efficient naval officers has been formed.

In 1875 the naval force was thus constituted:—

	Number	Guns
a. Steam-vessels—		
Armour-plated ships	19	73
Frigate	1	12
Corvettes	8	61
Gun-boats	23	47
Transports	7	
b. Sailing-vessels—		
Corvette	1	22
Sloops and smaller vessels	2	15
	61	230

These vessels were manned by 4136 seamen, including gunners and marines. One armoured vessel and four corvettes were on the stocks in 1875.

The Roman Catholic is the established religion of the empire. All other forms of worship are tolerated, but may only be practised privately. Dissenters enjoy all political and civil rights, with the sole exception of being elected into the chamber of deputies. The peculiarity of the ecclesiastical organization of the Brazilian church is, that the clergy do not receive the tithes. As a conquest of the military and religious order of Christ, all the churches of Brazil belonged from the beginning to that order, whose grand-master appointed the bishops, and submitted them directly to the approbation of the Pope. The order became so powerful that the king obtained the union of the grand-mastership to the crown, and so disposed of all the livings and other benefices of the order, and paid from his treasury the salaries of the clergy, receiving the tithes from the people as a civil tax. The tithes were afterwards abolished as oppressive. This organization is still recognized by the Holy See, and in the capacity of grand-master of the order of Christ the emperor appoints all the bishops and other ecclesiastical functionaries. There are convents of Franciscans, Carmelites, and Benedictines. These are very rich, and generally very learned men, who are usefully employed in teaching the sciences. They pay double annual taxes as a compensation to the treasury for not paying taxes upon transfers of property, as theirs is not transferable.

Primary and public schools, supported by the state through the provincial and municipal legislatures, for gratuitous instruction, have been established throughout the empire, under the general control of the ministry of the interior. In some of the provinces instruction has been made obligatory. Besides these, in which the teaching is limited to moral and religious instruction, reading and writing, the elements of grammar and arithmetic, there is a second or higher order of schools in most of the provinces, either public or private, in which such subjects as the elements of history and geography, especially that of Brazil, the principles of the physical sciences, elementary mathematics, drawing, Portuguese, French, and English are added. The Dom Pedro II. Imperial College of the capital has twenty-two professors, and provides a course of study of seven years, at the termination of which a degree of B.A. may be gained. Each diocese has a seminary for theological instruction, and these, with the exception of that of S. José in the capital, are subsidized by Government. Military training is under the care of the war department, and is carried on in preparatory and regimental schools, and further in military academies in the capital and in Rio Grande do Sul. A practical school of gunnery is established in the Campo Grande, near the capital; a central college with eleven professors also educates in the higher branches of military science and engineering.

An imperial astronomical observatory has been appended to the central college for the instruction of observers, and the recording of astronomical and meteorological phenomena. There is also a state observatory in Pernambuco. The naval college is established on board a war vessel,—the cadets being drafted to it from a preparatory naval

[1] Assumed to be at 200 paper for 100 gold.

school. A practical school of artillery is attached, and naval construction is taught in some of the higher national schools; but students are also sent to the best European navy yards. There are two faculties of medicine, one at Rio de Janeiro, and another at Bahia, each having a curriculum of six years, and conferring degrees. The faculties of law are seated at São Paulo and Recife in Pernambuco. An institute of commercial instruction is presided over by a Government commissioner in Rio. Other remarkable institutions are those for the education of the blind in Rio, and a deaf and dumb institute. An academy of fine arts is established, with schools, in Rio, as well as a conservatorium of music. A national museum of natural history was created in Rio in 1817, and is the most important of South America. Others of like character have been founded in Pará, in Ouro Preto, and in Ceará. The national public library in Rio is the most important establishment of its kind, having more than 100,000 volumes on all subjects. Extensive libraries are also attached to all the colleges and academies; and popular libraries have been created in each of the provincial capitals.

The press is represented by six daily newspapers in the capital, of which the *Diario do Rio* is the oldest, having been founded in 1817. The provincial towns together have nearly 200 newspapers.

The most important of the scientific societies of the empire is the Historical, Geographical, and Ethnographical Institute of Brazil, founded in 1838. There are besides this twenty larger scientific associations in Rio and the provincial capitals. With all these appliances, however, owing to the immense territory over which the population is scattered, the spread of instruction is exceedingly difficult, and the grossest ignorance yet abounds in the interior of almost every province.

It is obvious, from the insufficient establishments for general education, that the intellectual development of individuals must have been for a long period achieved in a great measure by unaided exertions. Now things are better, but in the more thinly inhabited districts devotion to such pursuits must not be expected in men exclusively occupied in procuring subsistence and securing self-defence. Even where the population is more dense, a lazy feeling of animal comfort represses the exertions of the majority. It is among the more aspiring class, who aim at the learned professions or state employment, and who are consequently obliged to cultivate their minds, that we must look for that attachment to intellectual pursuits which is rarely acquired except from habit. In the theological seminaries, established at the seat of each bishop, little more was inculcated than a knowledge of the classics, an outworn scholastic system of logic, and a knowledge of the routine duties of a priest. The schools of medicine in Rio Janeiro and in Bahia, from the attention bestowed upon practical surgery and anatomy, have done more to awaken the mind. The situations under Government requiring a certain proficiency in practical mathematics and natural history have also diffused a knowledge of and a taste for these pursuits. The number of foreign engineers and naturalists encouraged to settle in Brazil has rendered the natives in some measure acquainted with all that has been of late achieved in Europe in the mathematical and experimental sciences.

In parliament and by the press the most delicate political questions have been discussed with success, and the progress of the Government and of legislation evinces a certain administrative foresight and prudence rarely displayed by other new states.

The Brazilians who frequent the university of Coimbra in Portugal often distinguish themselves among their fellow-students; and notwithstanding the difficulties they have to contend against, not unfrequently rise to the highest offices of the state.

Literature.

The most remarkable writers in the Portuguese language on political economy and commercial law were Couttinho, bishop of Pernambuco, and Silva Lisboa, afterwards Viscount de Cayron, a senator of the empire, both Brazilians. Among historians the Brazilian Rocha Pita is distinguished, and Moraes the lexicographer of the Portuguese language belonged to Pernambuco. Portugal is poor in dramatic literature, but one of her most distinguished comic poets was the Brazilian Silva, who afterwards fell a victim to the inquisition of Lisbon. In epic poetry, on the other hand, Portuguese literature is rich. Brazil claims the authorship of two of its most beautiful poems of this class, the *Caramuru* of Durão, and the *Uruguay* of Gama. The best of the minor poets is Gonzaga, whose collection of lyrics is well known under the title of *Marilia de Dircêo.* Little inferior to him is Souza Caldas, whose translation of the Psalms denotes a talent of the first order. Claudio, Avarenga, Gregorio de Mattos, Euzebio de Mattos, Gusmão, in former times; and more recently, Odorico, Mendes, Borges de Barros, Domingos Magalhaës, Marquis of Paranaguá, A. de Macedo, Porto-Alegre, Barbosa, and others are well worthy of notice as lyric poets.

Religious eloquence was formerly much cultivated in Brazil, and Vieira is one of the most original and eloquent preachers known. In more recent times Antonio Carlos and Montalverne deserve particular notice. In the natural sciences Frei Leandro, Arruda, Camara, and José Bonifacio de Andrada are known for their works and discoveries.

Fine art.

In sacred music José Mauricio, a mulatto, left compositions of merit that were executed in the chapel of D. John VI.

The Brazilians have a natural taste for music, and an Italian theatre, maintained with but little interruption in Rio de Janeiro, has assisted in improving and refining this taste. The old-fashioned Brazilian instrument, which was a particular kind of guitar, has almost disappeared from the large cities, but is still frequently employed in the provinces to accompany the *modinhas* (romances) which are peculiar to Brazil, and which have a particular style.

The school of the fine arts of Rio de Janeiro has produced some good but no remarkable painters. Of late, however, the most promising artists have been annually sent to Italy at the public expense to prosecute their studies in that country.

National character.

The Brazilians are in general hospitable, generous, and charitable, endowed with great pride and vanity, and susceptibility of character, and are easily led away by flattery. The unlimited power they exercise over the African slaves, and the colonial system from which they have but a short time been freed, the imperfect religious education, the facility with which they can live in abundance at small cost, while the climate enables them to dispense with many things necessary in other countries, the enervating effects of the hot atmosphere, all combine to stimulate the qualities and vices which we must expect in this people.

There is in the Brazilian national character, with great mildness and generosity, a certain tendency to vindictiveness. Homicides for the sake of vengeance alone are proportionally as numerous in Brazil as in certain countries of Europe; while the crimes against property are much fewer. The greatest number of homicides, however, takes place in the most backward provinces of the centre and north.

The Roman Catholic religion predominates in Brazil, and although there are enlightened men among the clergy, a great number of the priests are ill educated, and the institution of celibacy keeps the members of the principal

families from entering the profession. Such is the want of priests that the Government finds itself obliged to send to Italy for them. Among educated classes the spirit of materialism of the French writers of the 18th century made great progress, but a considerable reaction has lately taken place. The lower classes, above all in the interior, are still deplorably superstitious.

In several of the provinces contentions have arisen of late years between the church and freemasonry, and the excommunication of the members of the craft and the closing of the churches to which they belonged have awakened religious discussions and agitations. The Jesuit priests were expelled from the province of Pernambuco in 1875, and the bishop of that diocese, tried before the lay tribunal, was condemned to fine and imprisonment.

Brazil is not specially a manufacturing country, and its national industries of mining (with smelting of the metals), collecting and polishing precious stones, and salt making, already referred to, with tanning and hide working, have the widest range. The state has, however, encouraged and in some cases subsidized special manufactures which were of value in developing the resources of the country. Among these seventeen foundries, manufacturing engines and agricultural implements, have supplied a great national want. The home hat factories of Brazil have now all but superseded the imported hats by their products. In almost every city there are manufactories of soap, oil, and candles, which are made, not only of stearine and tallow, but of wax, and in the north from the valuable Carnauba palm. Rum distilling is largely carried on in the sugar districts, and cigars are extensively made, especially at Bahia. Gold and silver smiths and jewel workers are foremost among the delicate handicraftsmen, and excel in their workmanship.

There are now two cotton-cloth factories in Rio, five in Bahia, two in Minas, and several in S. Paulo, and this branch of industry is extending.

Ship-building is diligently prosecuted in many of the ports, and Rio has launched several fine iron-clad vessels from the navy yard. A law passed in 1871 enabled Government to subsidize companies for the construction of more commodious docks, and these have been begun in Rio, Bahia, and Maranhão, at Santos in S. Paulo, and at Paranaguá in Paraná.

Whale-fishery is carried on to some small extent from the ports of Bahia and Sta. Catharina. The fine coastal fisheries are not yet taken advantage of to nearly their full power; on the other hand, large quantities of dried cod-fish are imported. On the upper Amazon and its tributaries a considerable quantity of oil is collected from the eggs of the turtle, and is sent down in earthen pots containing 50 to 60 lb weight each.

Jerked beef, an important article of general consumption, is chiefly prepared in the "Charqueadas" of Rio Grande do Sul.

The coastal and fluvial communications of the empire are maintained by eighteen lines of steam-vessels, which receive an annual subsidy from the state (amounting to £150,000 in 1875). A North American company, keeping up a regular traffic between the ports of Brazil and the United States, is also aided by Government. Besides these the ocean lines of large vessels from Britain, Germany, and France, touch regularly at the chief points in passing to the La Plata. Almost all the navigable rivers of Brazil have now their regular steam packets. The Amazon has been navigated by steam for nearly twenty years; and since the passing of the decree of September 1867, by which its waters were opened to the trading ships of all nations, direct commerce from foreign countries with the interior ports on its banks has begun to be developed.

Within recent times the construction of railroads has been progressing very rapidly under the Government and in private hands. In 1867 there were but six short lines working; in 1873 there were fifteen distinct railways. Three main trunk lines are being actively extended by the state: the first called the Dom Pedro II. line, passing from Rio de Janeiro to Minas Geraes, is being extended thence to the head of the navigation of the São Francisco, and is planned to reach the valley of the Tocantins and Pará; the second trunk line is designed to unite the navigation of the Amazon with that of the Paraguay, through the head of the valley of the Tocantins and Araguaya; the third line, already partly executed, beginning at Rio will pass through the capitals of S. Paulo and Paraná to Porto Alegre in Rio Grande do Sul. Many other lines have been begun or are projected under the superintendence of the provincial assemblies. The ordinary roads are in an exceedingly backward condition throughout the empire, and those which are more than rude tracks are of very small extent. A fine macadamized road, however, called the "Union and Industry," joins the capital with Minas Geraes, and others extend for short distances from the chief towns. There are also a few canals. It is but seventeen years since the first small line of telegraph was stretched in Brazil within the capital, but now a double line unites the maritime towns from Pernambuco to Rio Grande do Sul. Many other lines are being constructed, and in June 1874 submarine telegraphic cable was completed from Europe to the Brazilian ports.

The commerce of Brazil, despite the disadvantages against which it has had at various times to contend, has been on the whole uniformly progressive. These disadvantages consisted chiefly in the restrictions originally imposed on the young colony by the jealousy of the mother country, which refused to admit the Brazilian products except at certain stated seasons of the year. The exportation of native productions to the Old World was limited to the ports of Rio, Bahia, Olinda, and Paraiba. These restrictions continued in force long after analogous measures had been exploded in the commercial systems of other countries, and were not repealed till the beginning of the present century. In 1810, all the ports of Brazil were thrown open to British goods on the payment of duty at the rate of 15 per cent., and though this rate has been greatly increased by the tariff of 1844, the average annual value of manufactured goods imported into Brazil from Great Britain alone, chiefly cotton, iron, woollen, and linen goods, amounts to nearly £4,500,000.

The value of the imports and exports of Brazil in 1808 was estimated at £2260; it has gradually increased, with little fluctuation, till at the present time the annual value of trade is not less than £40,000,000. The trade of the empire is mainly with Great Britain (which sends more than a third of the imports, and receives a great share of the exports), France, the United States, Portugal, Germany, the Argentine Republic, and Belgium. In the order of their value the chief exports are coffee, hides, sugar, cotton, india-rubber, tobacco, yerba-mate, diamonds, and rum. Since 1853 the value of the exports from the country has in most years been somewhat in excess of that of the imports. The whole number of ships entering and leaving the Brazilian ports in recent years averages about 30,000.

See *Brazil and the Brazilians*, Rev. D. P. Kidder and J. C. Fletcher, 1857; *The Naturalist on the River Amazons*, H. W. Bates, 1863; *Travels on the Amazon and Rio Negro*, Alfred R. Wallace, 1853; *The Amazon and Madeira*, translated by Church, Keller, 1874; *Explorations of the Highlands of Brazil*, Capt. R. F. Burton, 1869; *Journey in Brazil*, Professor Louis Agassiz, 1868; *Scientific Results of a Journey in Brazil by Professor Louis Agassiz*, by Professor C. F. Hartt, 1870; *Climat, géologie, faune, et géographie botanique du Brésil*, Emmanuel Liais, 1872; *Notions on the Chorography of Brazil*, J. Manoel de Macedo, translated by Le Sage, 1873; *The Empire of Brazil at the Vienna Exhibition*, Rio de Janeiro, 1873; *The coast of Brazil, and trade of its ports*, Lieut.-Commr. H. H. Gorringe, Washington, 1873; *Atlas do Imperio do Brazil*, por Candido Mendes de Almeida, Rio de Janeiro, 1868.

(K. J.)

BRAZIL, Island of, and other imaginary islands in the Atlantic. For a long time before the discovery of America, the fancies of navigators or of cosmographers had scattered over the Atlantic a number of islands, either wholly imaginary, or so detached from the germ of truth which had suggested their existence as to represent no fact in nature. Several such islands are described in the Arabic geography of Edrisi (1153–54 A.D.), and if, passing over more than four hundred years, we take up an atlas of Münster or Mercator we shall find that the northern Atlantic, instead of presenting a vast blank as in our most recent charts, is almost as full of islands and shoals as the heaven is of stars. To our present category belongs the island of St Brandon, the supposed discovery of an Irish eremite of the 6th century, of whose voyage many wonders are related. Such also were *Antilia* and the *Island of the Seven Cities*, connected with another legend of uncertain date, which described this as the refuge of a body of Christians, who, in flight from the Saracen conquerors of the Peninsula, had, under the guidance of their seven bishops, committed themselves to the wide ocean; such were *Mayda* or *Asmaide*, the *Isla Verde*, or Green Isle (which the natives of the Hebrides still think they see beneath the western sun), but none more famous and recurrent than the *Isle of Brazil*. The name of this island connects itself with the red dye-woods known by that name in the Middle Ages, a name that possibly also may have been applied to other vegetable dyes, and so may descend from the *Insulæ Purpurariæ* of Pliny. Its first appearance on a map appears to be (*I. de Brazi*) in the Venetian portulano of Andrea di Bianco (1436), where it is found attached to one of the larger islands of the Azores. When this group became better known and was colonized, the island in question got the name of Terceira. And the conservative spirit of map-makers then sought a new position for that Island of Brazil which they found in the charts of their predecessors, and this island grew in (imaginary) importance and size. In time, better knowledge of the Atlantic showed that these must be exaggerated, but belief in the island's existence endured.

The conservative spirit just referred to has indeed preserved in some shape most of the names mentioned above. The name of the *Seven Cities* survives as applied to a volcanic district of the Island of St Michael's (Azores). *Antilia* and *St Brandon's Isle* were conspicuous on the maps which were probably in the hands of Columbus on his first western voyage. The latter name has disappeared indeed, but the former survives in a plural form, as applied to the West Indies (*Antilles*). So also it is probable that the familiar existence of "Brazil" as a geographical name led to its bestowal upon the vast continental region of South America, which was found to supply dye-woods kindred to those which the name properly denoted. The older memory, however, survived also, and the *Island* of Brazil retained its place in mid-ocean, some hundred miles to the west of Ireland, both in the traditions of the forecastle and in charts. In Purday's *General Chart of the Atlantic*, "corrected to 1830," we find the *Mayda* indeed noted as "very doubtful," but "*Isle Verte or Green Rock*" (44° 48′ N. lat., and 26°10′ W. long.) with the remark, "Existence lately confirmed;" and "*Brazil Rock* (high)," with no indication of doubt, in 51° 10′ N. lat., 15° 50′ W. long. In a chart of currents by the late Mr Findlay, dated 1853, these names appear again. But in his 12th edition of Purday's *Memoir Descriptive and Explanatory of the N. Atlantic Ocean* (1865), the existence of these islands is briefly discussed and rejected by Mr Findlay, with the intimation that their names would be entirely omitted in future editions.

Thus the official sepulture of the old tradition of the island of Brazil took place only eleven years before the date of this article (1876). And now the surface of the Atlantic, as represented in the latest Admiralty charts, shows between St Kilda and Bermuda, between Newfoundland and the Azores, but one point rising above the water, viz., the sugar loaf of *Rockall*, in 57° 35′ 52″ N. lat., 13° 42′ 21″ W. long. (H. Y.)

BRAZIL NUTS are the seeds of *Bertholletia excelsa* (*B. nobilis* of Miers), a gigantic tree belonging to the natural order *Lecythidaceæ*, which grows in the valleys of the Amazons and generally throughout tropical America. The tree attains an average height of 130 feet, having a smooth cylindrical trunk, with a diameter of 14 feet 50 feet from the ground, and branching at a height of about 100 feet. The lower portion of the trunk presents a buttressed aspect, owing to the upward extension of the roots in the form of thin prop-like walls surrounding the stem. The fruit of the tree is globular, with a diameter of 5 or 6 inches, and consists of a thick hard woody shell, within which are closely packed the seeds which constitute the so-called nuts of commerce. The seeds are triangular in form, having a hard woody testa enclosing the "kernel;" and of these each fruit contains from eighteen to twenty-five. The fruits as they ripen fall from their lofty position, and they are at the proper season annually collected and broken open by the Indians. From Para alone it is estimated that upwards of two and a half millions of fruits, equal to fifty millions of "nuts," are exported annually, in addition to the large quantities which leave other Brazilian harbours, and Demerara, Cayenne, &c. Brazil nuts are largely eaten; they also yield in the proportion of about 9 oz. to each pound of kernels a fine bland fluid oil, highly valued for use in cookery, and used by watchmakers and artists.

BRAZIL WOOD is one of several dye woods of commerce which come from the West Indies and South America, belonging to the genera *Cæsalpinia* and *Peltophorum* of the natural order *Leguminosæ*. The species to which the various woods belong have not been well determined, but commercially they are distinguished as Brazil wood, Nicaragua or Peach wood, Pernambuco wood, and Lima wood, each of which has a different commercial value, although the tinctorial principle they yield is similar. Commercial Brazil wood is imported for the use of dyers in billets of large size, and is a dense compact wood of a reddish brown colour, rather bright when freshly cut, but becoming dull on exposure. The colouring-matter of Brazil wood is freely soluble in water, and it is extracted for use by simple infusion or decoction of the coarsely-powdered wood. When freshly prepared the extract is of a yellowish tint; but by contact with the air, or the addition of an alkaline solution, it develops a brick red colour. A chemical principle, termed brazilin, has been isolated from Brazil wood. It crystallizes into hexagonal amber yellow crystals, which are soluble in water and alcohol. The solution when free of oxygen is colourless, but on the access of air it assumes first a yellow and thereafter a reddish yellow colour. With soda-ley it takes a brilliant deep carmine tint, which colour may be discharged by heating in a closed vessel with zinc dust, in which condition the solution is excessively sensitive to oxygen, the slightest exposure to air immediately giving a deep carmine. With tin mordants Brazil wood gives brilliant but fugitive steam reds in calico-printing; but on account of the loose nature of its dyes it is seldom used except as an adjunct to other colours. It is used to form lakes which are employed in tinting papers, staining paper-hangings, and for various other decorative purposes.

BRAZZA, the ancient *Brattia*, an island in the Adriatic, off the coast of Dalmatia, in the circle of Spalatro, and eight miles from that city. It has an area of 170 square miles, and a population of 15,500. The surface is rugged and mountainous, but is industriously cultivated, and its wine is accounted the best in Dalmatia. It produces also oil, figs, almonds, and saffron; but the corn crop scarcely supplies the wants of the inhabitants for three months. There are about twelve or thirteen hamlets in the island, the most important being San Pietro, Neresi, Bol, and Milnä.

BREAD. See Baking, vol. iii. p. 250.

BREAD-FRUIT. This most important food staple of the tropical islands in the Pacific Ocean is the fruit of

Artocarpus incisa (nat. ord. *Artocarpaceæ*). The tree attains a moderate height, has very large, acutely lobed, glossy leaves, the male flowers in spikes, and the female flowers in a dense head, which by consolidation of their fleshy carpels and receptacles form the fruit. The fruit is globular in shape, about the size of a melon, with a tuberculated or (in some varieties) nearly smooth surface. Many varieties of the tree are cultivated, the fruits of some ripening numerous seeds, which are eaten as chestnuts; but in the best kinds the seeds are aborted, and it is only these that are highly prized as vegetables. The tree is a native of the South Sea Islands, where its fruit occupies the important position that is held by cereals in temperate latitudes. The fruit, which on distinct varieties ripens at different periods, affording a nearly constant supply throughout the year, is gathered for use just before it ripens, when it is found to be gorged with starchy matter, to which its esculent value is due. It may be cooked and prepared for use in a great variety of ways, the common practice in the South Sea Islands being to bake it entire in hot embers, and scoop out the interior, which when properly cooked should have a soft smooth consistence, fibrous only towards the heart, with a taste which has been compared to that of boiled potatoes and sweet milk. Of this fruit Mr A. R. Wallace, in his *Malay Archipelago*, says,—"With meat and gravy it is a vegetable superior to anything I know either in temperate or tropical countries. With sugar, milk, butter, or treacle it is a delicious pudding, having a very slight and delicate but characteristic flavour, which, like that of good bread and potatoes, one never gets tired of." In the Pacific Islands the fruit is preserved for use by storing in pits, where the fruits ferment and resolve themselves into a mass similar in consistency to new cheese, in which state they emit an offensive odour; but after baking under hot stones they yield a pleasant and nutritious food. Another and more common method of preserving the fruit for use consists in cutting it into thin slices, which are dried in the sun. From such dried slices a flour may be prepared which is useful for the preparation of puddings, bread, and biscuits, or the slices may be baked and eaten without grinding. The tree yields other products of economic value, such as native cloth from the fibrous inner bark of young trees; the wood is used for canoes and articles of furniture; and a kind of glue and caulking material are obtained from the viscid milky juice which exudes from incisions made in the stem.

The bread-fruit is now found throughout the tropical regions of both hemispheres, and its first introduction into the West Indies is connected with the famous mutiny of the "Bounty," and the remarkable history of a small company of the mutineers at Pitcairn Island. Attention was directed to the fruit in 1688 by Captain Dampier, and later by Captain Cook, who recommended its transplantation to the West Indian colonies. In 1787 the "Bounty" was fitted out under command of Lieutenant Bligh to proceed to Tahiti to carry plants thence to the West Indian Islands; and it was after the cargo had been secured and the vessel was on her way that the mutiny broke out, and Lieutenant Bligh and some of his crew were turned adrift in a small boat in the open sea. The mutineers returned with the vessel to Tahiti, whence a number of them, with a few native men and women, sailed to the desolate and lone islet of Pitcairn. Lieutenant Bligh ultimately reached England, and was again commissioned to undertake the work of transplanting the plants, which in the year 1792-3 he successfully accomplished.

A somewhat similar but much inferior fruit is produced by an allied species, the Jack or Jak, *Artocarpus integrifolia*, growing in South India, Ceylon, and the Eastern Archipelago. This tree is chiefly valuable on account of its timber, which has a grain very similar to mahogany, and although at first light coloured it gradually assumes much of the appearance of that wood.

BREAKWATERS differ from piers in their not being necessarily adapted for commercial purposes. They do not, therefore, require to have roadways for the accommodation of traffic, or parapets for keeping water or spray from passing over them. Breakwaters are artificial structures consisting generally of stones or blocks of concrete, built or deposited in deep water. Their object is to tranquillize those portions of the sea which they cover, and which thus become sheltered anchorages. They may be divided into three classes:—(1.) Vertical or nearly vertical structures of built masonry for arresting the onshore progress of the waves, and for either reflecting them seawards or deflecting them laterally. (2.) Sloping structures of rubble stones dropped into the sea from timber stages or floating barges, and hence termed *pierres perdues*, having a sloping face on each side, termed a *talus* or *glacis*. These slopes, which, after the blocks have been consolidated, are generally protected above low water by stones set closely together, called *pitching*, are the angles of repose assumed by the loose blocks under the influence of the waves, and vary in steepness from above high water to below low water, where the force of waves is least. They vary from about 1 foot horizontal to 1 foot vertical to 7 feet horizontal to 1 foot vertical. (3.) What may be termed composite breakwaters are partly sloping and partly vertical, and act by causing the waves to break, and also by partially reflecting them seawards or deflecting them laterally. The new breakwater at Aberdeen and the Dover Admiralty pier, which acts also as a breakwater, are examples of the *first* class. Plymouth breakwater, which rises with a general sea-slope of from 2 to 5 horizontal to 1 vertical to a height of 23 feet above high water, is an example of the *second* class. Cherbourg, which slopes from low water to high water, above which level there is a vertical barrier rising to 12½ feet above high water, is an example of the *third* class. Breakwaters, though passive, are nevertheless real agents by which work is done in combating the waves in one or other of the three modes which have been defined. For further information regarding the design of breakwaters and the details of their construction see HARBOURS.

BRECHIN, a parliamentary burgh of Scotland in the county of Forfar, 7½ miles W. of Montrose, and connected by a branch-line with the Caledonian Railway. It is situated on an abrupt declivity on the north bank of the River South Esk, here crossed by a stone bridge of very early date. The principal buildings comprise the parish church (with steeple and spire 128 feet high)—forming part of an ancient and uncompleted cathedral, of Gothic architecture, which has been injured by modern alterations. several other churches, a town-house, the public and Smith's school, a mechanics' institute, and an infirmary. The diocesan library hall of the Episcopal church contains an extensive and valuable collection of books, many of them presented by Bishop Abernethy-Drummond, and about 2000 by the late Bishop Forbes, who erected the building. Some ruins remain in the "vennel" of the Maison Dieu, or *hospitium*, founded by William of Brechin in 1256. The most remarkable edifice, however, is the round tower, situated in the churchyard near the cathedral. This tower is similar to those so common in Ireland, but in Scotland is only rivalled by the tower at Abernethy. Like similar buildings, it contains no stair, and the only access to the top is by means of ladders placed on wooden floors, which rest on circular stone projections within the tower. The height from the ground to the roof is 86¾ feet, the inner diameter within a few feet of the bottom is 8 feet, and the thickness of the wall at that part about 4 feet; the circum-

ference is very near 50 feet; the inner diameter at top is 6 feet 7 inches, the thickness of the wall 2 feet 10 inches, and the circumference 38 feet 8 inches. These proportions give the building a high degree of elegance. The top is roofed with an octagonal spire 18 feet high, which makes the whole height of the building 101 feet 9 inches. Brechin Castle, which was a place of some strength during the Wars of the Independence, now a seat of Lord Dalhousie, lies a little to the south of the town. There is a public park near the town, and two large nurseries. There are three extensive power-loom linen factories (one of them a building of much taste), two bleach-fields, two distilleries, a brewery, and a paper-work; and extensive freestone quarries exist in the neighbourhood. The town is lighted with gas, and an ample supply of water has been introduced at great expense. Weekly markets are held on Tuesdays; and statutory fairs for horses, cattle, and sheep are held at Trinity Muir, about a mile north of the town. Brechin unites with Montrose, Arbroath, Forfar, and Bervie in returning one member to parliament. The population of the parliamentary burgh was in 1871, 7959; and of the royal burgh, 5083.

Brechin is a place of great antiquity, and was chosen by the Culdees as the site of one of their convents. It is said to have been burned by the Danes in 1012. In 1150 it was erected into a bishopric by David I. In 1572 James VI. gave a grant for founding a hospital in the burgh, which still supplies the magistrates with funds for charity. In 1645 the town and castle were harried by the marquis of Montrose. Maitland the topographer and Gillies the historian of Greece were natives of Brechin.

BRECON, or Brecknockshire, an inland county in South Wales. Its greatest length from south to north is about 53 miles, and its greatest breadth from east to west about 46 miles. It possesses an area of 719 square miles, or 460,158 acres, and is thus the fourth largest county in Wales. It is said to have derived its name from Brychan, a Welsh prince, who flourished in the fifth century.

The Old Red Sandstone is the principal geological formation in this county, and occupies the whole of the central portion from east to west. Along the southern boundary there extends a narrow belt of carboniferous limestone, millstone grit ("farewell rock" of the miners), and the outcrop of the coal beds,—together forming the northern rim of the coal measures in the great South Wales coal-field. At Clydach in Llanelly, Brynmawr, Hirwaun, and a few other places on the south-eastern border of the county, there are extensive iron-works. The narrow projecting part of the county to the north, lying between Radnor and Cardigan, is occupied by the Upper and Lower Silurian beds; and there is a somewhat singular narrow peninsula of the former projecting into the Red Sandstone for a distance of ten miles, in a S.W. direction, and terminating at about five miles north of the town of Brecon. A belt of limestone extends from the town of Hay on the east, and passing in a S.W. direction through the town of Brecon, terminates at the Brecknockshire Van. A prominent band extends along the border of the Old Red Sandstone on the N.W., where it joins the Silurian beds.

The general aspect of the county is mountainous, and the scenery is marked by beauty and grandeur. A chain of the loftiest mountains in South Wales completely encircles the south, composed in the east of the Black Mountains, 2545 feet in height, and the curious Sugar Loaf rising to the height of 1760 feet. On the west of Brecknockshire are the Van and Talsarn mountains 2596 feet, and Mount Capellante 2394 feet in height; while the centre of the crescent is occupied by the masses of the Brecknockshire Beacons, the highest point of which, Cader Arthur, or Arthur's Chair, attains an altitude of 2910 feet. In the north, a range of barren hills, called Mynydd Bwlch Groes at the most westerly end and Mynydd Epynt towards the east, enters the boundary of the county at a short distance from Llandovery in Carmarthenshire, and extending in a N.E. direction, terminates near Builth.

Of the valleys the most distinguished for beauty is that of the Usk, stretching from east to west, and dividing the county into two nearly equal portions. The Wye is the chief river, and forms the boundary on the N. and N.E. from Rhayader to Hay, a distance of upwards of twenty miles; while the Towy, the Afon Claerwen, and the Elan separate the county from Cardigan and Radnor on the N.W. and N. The Usk rises in the Carmarthenshire Van on the west, and flowing in a direction nearly due east through the centre of the county, collects the waters from the range of the Beacons in the south, and from Mynydd Bwlch Groes and Mynydd Epynt in the north, by means of numerous smaller streams (of which the Tarell and the Honddu are the most important), and enters the county of Monmouth near Abergaveny. The Taff, the Hepstau, and the Tawe, all rise on the south of the Beacon range, and passing through Glamorganshire, flow into the British Channel.

Llyn Safaddu, Llangorse Lake, or Brecknioc Mere, the largest lake in South Wales, is situated at the foot of the Black Mountains, and within the county. It covers an extent of nearly 1800 acres, and is about two miles long by one mile broad. Upon an artificial island in the lake traces of habitations raised on piles have lately been discovered, together with the bones of red deer, wild boar, and *Bos longifrons*. Tradition affirms that beneath the lake is a submerged town, which has been rashly identified with the Roman station *Loventium*.

The climate is moist, but temperate and salubrious; and the soil of the valleys, often consisting of rich alluvial deposits, is very fertile. The cultivated crops consist of wheat, oats, barley, rye, turnips, pease, potatoes, and vetches; of these the greater part is consumed within the county. The uplands are chiefly in pasture, and are stocked with sheep, cattle, and ponies, which with wool, butter, and oak-bark, form the staple of a considerable trade with the adjoining English counties, and with the iron districts lying to the south. The farms are generally small, but are well cultivated in the lower parts of the county. The highland occupiers are a very humble, hard-working class of men. It is calculated that about two-thirds of the lands in the county are enclosed.

Breconshire is intersected by the Mid Wales, Brecon, and Merthyr Railway, and a branch of the London and North-Western, by means of which there is ready com munication with all parts of the kingdom.

The principal towns are Brecon, Builth, Crickhowel, and Hay. The county returns one member to parliament, and has done so since 1536. The political influence is chiefly in the hands of Lord Tredegar and Sir Joseph Bailey. Constituency in 1875, 3574. Rents in the valley of the Usk and around Brecon are high, but on the mountain lands very low; it would be deceptive to give an average per acre. The annual value of real property paying income-tax is £316,208. The population of the county by the last census was 59,901, giving an average of 83 persons to a square mile, or 7·68 acres to each person. Of the total number 29,928 were males, and 29,973 females. The number of inhabited houses was 12,617, giving an average of 17·5 inhabited houses to a square mile, and 4·7 persons to each house. The following returns show an increase of population amounting to 34 per cent. during the last fifty years:—

1821	43,826
1831	47,763
1841	55,603
1851	61,474
1861	61,627
1871	59,901

The Welsh language is still that of the peasantry and middle class, and the members of the Church of England are largely out-numbered by the Baptists, Calvinistic Methodists, and Independents.

Brecknockshire formed part of the territory of the Silures, and its occupation by the Romans could never have been very complete. After their expulsion the district (*Brycheiniog*) was ruled by native princes and was the scene of many a border struggle. Many of the castles which are scattered over its eastern border had their origin at this period; and some of them may be regarded as advanced posts erected by the English during the wars which preceded the formation of Offa's Dyke. Subsequently, when Bernard de Newmarch and his Norman followers obtained possession of the country, they were converted into regular fortresses, by which the neighbourhood was kept in awe, and the mountain passes defended. The district between Brecon and Builth was the scene of the last struggle between the English and Llewelyn in 1282, when the Welsh chieftain was defeated and slain. Since that date Breconshire has not been associated with any important historical events, unless we include among them the raids of Owen Glyndwr. It formed part of the Welsh Marches until their union with England in 1532. Among the eminent natives of the county may be mentioned Sir David Gam (Shakspeare's Fluellen), who lost his life at Agincourt while defending Henry V.; the ill-fated Henry Stafford, duke of Buckingham; John Penry ("Martin Marprelate"); Henry Vaughan, the poet; Dr Hugh Price, founder of Jesus College, Oxford; Thomas Howel, bishop of Bristol (less known than his brother, the letter writer); Theo. Jones, historian of the county; and Mrs Siddons.

Brecon, or Brecknock, the capital of the county of the same name, a market and borough town, 145 miles N. by W. from London, picturesquely situated in a fine open valley, at the confluence of the Honddu and Tarell with the Usk, and nearly in the centre of the county. It is supposed to occupy the site of the Roman station *Bannium*, but it is more probable that it was partly constructed with materials drawn from that spot, which lies to the W. of the present town, on the Via Julia Montana. There are three main streets, with several smaller ones. The houses are for the most part constructed of stone, and are generally well built. Brecon has a fine cruciform church (Early English in style), which has been restored by Sir Gilbert Scott. There are two other churches, and two Independent, two Baptist, and one Calvinistic Methodist chapel. The corporation consists of a mayor, recorder, four aldermen, and twelve councillors. The borough has returned one member to parliament since 1536. Constituency in 1875, 813. The assessed taxes yield annually £1259, and the annual value of real property paying income-tax is £24,941. There are weekly markets, and several fairs in the course of the year. The quarter sessions and assizes are held here. Brecon has a foundation called the College of Christ Church, of which the bishop of St David's is *ex officio* dean, but after the death of its present officers its revenues will devolve to the ecclesiastical commissioners and be appropriated to ecclesiastical uses. The ruins of the ancient castle are enclosed in the beautiful grounds of the Castle Hotel, and though unimportant in themselves, derive an interest from their connection with the Fitzwalters, de Braoses, de Bohuns, and Staffords, successive lords of Brecon. The principal fragment now remaining is Ely Tower, so called from its having formed the prison of Morton, bishop of Ely, where he concerted with his custodian, Henry Stafford, duke of Buckingham, the dethronement of Richard III., and the union of the houses of York and Lancaster. There are some fine Roman and other remains in the immediate vicinity. Population of municipality in 1871, 5845; inhabited houses, 1172.

BREDA, a town of Holland in the province of North Brabant, and capital of a circle, is situated in a marshy plain on the Merck, 24 miles S.W. of Bois-le-Duc, and 30 N.N.E. of Antwerp. It is strongly fortified and defended by a citadel (rebuilt by William III. of England), and the surrounding district may be laid under water when required. The town is well built, with wide and well-paved streets, is intersected by several canals, and has a fine quay, a town-hall, an arsenal, an observatory, an orphan asylum, a cathedral, and several Roman Catholic and Protestant churches, one of the latter having a spire 362 feet in height. It has also a Latin school and a military academy, and manufactures of linen and woollen goods, carpets, hats, beer, and musical instruments. Population (1869), 14,172.

Breda obtained municipal rights in 1252 from Henry, but was not surrounded with walls till 1534. The old castle, which had been built in 1350 by Jan Van Polanen, was restored about the same time. It was the residence of Charles II. in his exile. In 1696 William Prince of Orange and king of England caused the erection of the new castle, which was regarded as one of the finest buildings of the period. This is now the seat of the military academy. The town was captured by the Spaniards in 1581, by Maurice of Orange in 1590; again by the Spaniards, under Spinola, in 1625; and by Henry of Orange in 1637. It was finally ceded to Holland by the treaty of Westphalia in 1648. During the wars of the French Revolution it was taken by Dumouriez in 1793, and again by Pichegru in 1795. Much of its celebrity is due to the various political congresses of which it has been the scene. In 1566 the nobles of the Netherlands formed there the league known as the Compromise; in 1575 a conference was held between the ambassadors of Spain and those of the United Provinces; in 1667 a peace was signed between England, Holland, France, and Denmark; and in 1746–7 the representatives of the same powers met in the town to discuss the terms of another treaty.

BREDA, Jan Van, a Dutch painter, was the son of Alexander Van Breda, an artist of considerable merit, and was born at Antwerp in 1683. He imitated the style of Wouvermans and Breughel with such dexterity, that even connoisseurs are often unable to distinguish his copies of their pictures from the originals. He visited England, where he was so well employed, that in a few years he was able to retire to his native country with a competency. The earl of Derwentwater was one of his chief patrons. He died at Antwerp in 1750.

BREDOW, Gabriel Gottfried, a German historian and professor in the university of Breslau, was born at Berlin in 1773. He is known in England by his *Manual of Ancient History*, which was translated into English in 1827; *Researches on History, Geography, and Chronology*; and his valuable *Historical Tables*, which come down to 1811. This last work was translated into English by Major J. Bell, who continued the tables down to 1820, and produced a popular and very useful work. Bredow died in 1814.

BREEDS AND BREEDING.[1] The word breeds is usually applied to the varieties of domesticated *animals* only, but since the phenomena presented under cultivation by all classes of organisms are entirely similar in character, and since, moreover, much of our knowledge on the subject has been gained from botany and horticulture, we shall include, under the one term breeds, the varieties of domestic animals and of cultivated plants. The natural and simple definition of breeding would be the art by which breeds are produced. But here the objection arises, that in this definition too much is assumed. It may be argued that our domesticated animals and plants are each

[1] Many of the facts and arguments contained in the present article are taken from Mr Darwin's work, *The Variation of Animals and Plants under Domestication*, 1868, and 2d. ed. 1875; and in most instances it has not been considered necessary to give the references.

identical with a wild prototype either living or extinct, and that man has merely deprived them of liberty and regulated their environment and propagation in the manner most advantageous to each kind. At the present day, when the whole range of biological thought is so largely permeated by the principles of the doctrine of evolution, this objection will probably not be advanced. Yet, when it is remembered that such an authority as Col. Hamilton Smith held the belief that each breed of dog had its wild prototype, it appears necessary to modify the definition above given. Let it be said that the art of breeding consists in changing the conditions of life and regulating the reproduction of animals and plants.

Since a breed is a domestic variety, it implies the existence of a group of individuals marked off from their congeners by the possession of certain characters which are transmitted to their offspring. It is this *transmission* of peculiarities which is the essential characteristic of a breed; for any collection of domesticated organisms could be divided into groups of individuals distinguished by certain points, but such groups would not necessarily form breeds. It is evident, then, that the law of heredity which asserts that "like begets like" must hold good, or the existence of breeds will be an impossibility. Again, if it were absolutely true that like begets like, that is, if the offspring were in all cases identical with the parent, it is evident that neither by man's interference, nor by the operation of nature, could a breed or race arise. It seems, then, that were it not in the nature of all organic beings to reproduce their kind in the manner formulated in the principle of heredity, and were it not for the continuous slight infringement of it expressed by the principle of variability, breeds could not have arisen. It is therefore necessary to examine these two principles as part of the subject under consideration.

Whatever views we may entertain respecting the origin of our domestic animals and plants, there can be no doubt as to the matter of fact that breeders have always proceeded on one principle,—*select the best individuals in each generation and pair them.* Now we have found that the qualities of organic beings (forming in a certain sense the material on which the breeder has to work) can be generalized under two principles—heredity and variability. And in the same way the art of breeding is itself capable of a kind of generalization under the principle of selection. There are thus three great principles or laws—heredity, variability, and selection,—the last relating to the art of man, the other two to those qualities of organic beings which render the art practicable.

Heredity.—The simplest form of heredity is found amongst those organisms which reproduce their kind by division into two parts similar to each other. This process is illustrated by the fission of a Moneron. The next advance in complexity of reproduction occurs when the two portions into which the organism divides are dissimilar to one another; here the process by which both portions ultimately assume the form of the parent is not one of simple nutrition, *i.e.*, of formation of tissue like that already formed. The process by which man propagates some of his cultivated plants is one of artificial reproduction by fission. For instance, a cutting or part of a shoot, or even a leaf (as with Begonia), if placed in suitable soil, will reproduce the original plant in all its minute details. We are here face to face with the mystery of reproduction; for we have the ever wonderful fact that in a few cells lies dormant the vital impetus which enables them to produce from inorganic pabulum a most complicated structure, which in its totality is utterly unlike themselves. And this example shows us, moreover, how essentially the same are sexual and asexual reproduction; for there is no intrinsic difference between reproduction from a small part artificially separated from a simple foliar organ (a leaf) and the same sequence of growth originating in a small portion naturally segregated from a transformed foliar organ (the ovary). The conditions of growth are not the same in the two cases, and there all essential difference ends; for the broad distinction which the congress of two individuals in one case appears to make is swept away by the facts of Parthenogenesis. In the lowest of living things we have seen that growth and reproduction are almost identical aspects of life. And this connection is not less close among higher organisms; as Mr Herbert Spencer observes,—"When in place of its lost claw a lobster puts forth from the same spot a cellular mass, which, while increasing in bulk, assumes the form and structure of the original claw, we can have no hesitation in ascribing this result to a play of forces like that which moulds the materials contained in a piece of Begonia leaf into the shape of a young Begonia. In the one case as in the other the vitalized molecules composing the tissues show their proclivity towards a particular arrangement; and whether such proclivity is exhibited in reproducing the entire form or in completing it when rendered imperfect matters not."[1] The main fact of inheritance is so obvious that it is apt to be forgotten. Mr Darwin remarks,—"It is hardly possible, within a moderate compass, to impress on those who have not attended to the subject the full conviction of the force of inheritance, which is slowly acquired by rearing animals, by studying the various treatises which have been published on the various domestic animals, and by conversing with breeders."[2] Certain peculiarities have appeared only once or twice in the history of the world, but have reappeared in children or grandchildren of the individuals so characterized. Thus Lambert "the porcupine man," whose skin was covered with warty projections, which were periodically moulted, had all his six children and two grandsons similarly affected. The most striking cases of inheritance have, as in this instance, been observed in man; but the very existence of the numerous breeds of domestic animals is clear evidence of the possibility of the transmission of every kind of peculiarity. For instance, it is believed that the varieties of the domestic pigeon amount to at least 150, and these races differ from each other in many ways, and all breed true to their kind. Some very curious peculiarities have been perpetuated. A race of cattle called "Dutch buttocked" was formed in Yorkshire by selecting in each generation the animals with the largest hinder-quarters. When the breed began to be established it was found that the large size of the calves' hind-quarters increased the dangers of parturition to a considerable extent. This case is interesting as showing that hurtful peculiarities may be inherited just as readily as those which are beneficial, and as bearing witness to the improbability of the view that there is an innate tendency to vary in the right direction. The terrible strength of inheritance exhibited by disease is a fact which is only too well established in the case of man; and in the maladies of domestic animals the same law holds good. It appears that nearly all the diseases to which the horse is subject are hereditary,—for instance, contracted feet, curbs, splints, spavin, founder, and weakness of the fore legs, roaring or broken and thick wind, melanosis, specific ophthalmia, and blindness, and even such habits as crib-biting and jibbing, are all plainly hereditary. The fact that any, even the most complex combinations of qualities are capable of hereditary transmission, is, perhaps, more forcibly brought home by considering the monetary aspect of the art of breeding, than by the fullest collection of special instances. As Mr Herbert Spencer remarks:—"Excluding those inductions

[1] *Principles of Biology*, London, 1866, p. 181.
[2] *Op. cit.*, vol. ii. p. 4.

that have been so fully verified as to rank with exact science, there are no inductions so trustworthy as those which have undergone the mercantile test. When we have thousands of men whose profit or loss depends on the truth of the inferences they draw from simple and perpetually repeated observations; and when we find that the inferences arrived at and handed down from generation to generation of these deeply interested observers has become an unshakeable conviction, we may accept it without hesitation. In breeders of animals we have such a class, led by such experiences and entertaining such a conviction—the conviction that minor peculiarities are inherited as well as major peculiarities. Hence the immense prices paid for successful racers, bulls of superior form, sheep that have certain desired peculiarities."[1] Not only are slight and gradual changes inherited, but in some cases sudden and well-marked variations are strongly transmitted. The case of the Niata cattle is now well known; a similar case is recorded of a rabbit born with only one ear, from which a breed was formed which steadily produced one-eared rabbits. These remarkable cases of sudden and large variation being inherited are closely allied to the still more curious phenomenon of the inheritance of mutilations. The most striking cases on record are those of Brown-Séquard.[2] In his experiments on the inheritance of artificially produced epilepsy he found that guinea pigs, after having undergone section of the sciatic nerve, often nibbled off portions of their hind legs in consequence of the anæsthesia of those parts. Now the offspring of these self-mutilated animals were in thirteen cases born without toes. To appreciate the true value of this case it must be noted that Dr Brown-Séquard has for thirty years kept guinea pigs, and has had many thousands under observation, and *not a single case* of congenitally toeless animals has occurred excepting among the offspring of mutilated parents. In spite of the universal tendency towards the transmission of the form and qualities of the parents to the offspring, there occur capricious and inexplicable lapses in inheritance. It is not possible logically to distinguish a want of inheritance from a case of variation; but when the difference between the offspring and the parent consists merely in the absence in the former of a quality possessed by the parent, it may be more conveniently classed as a want of inheritance than as an instance of variation. Although a weeping or pendulous habit in trees is in some cases strongly inherited, in other instances the want of inheritance is equally well marked. Mr Rivers sowed above 20,000 seeds of the weeping ash, and not a single seedling was in the least degree pendulous. M. Borchmeyer has also observed the same fact in Germany. In all cases it must be remembered that the form and qualities which the offspring of an animal or plant will assume when fully developed are not solely dependent on the nature of the hereditary impetus with which it starts; the initial tendency is as it were calculated so as to impart under certain conditions a certain form to the organism. If the conditions change, the initial tendency will not lead to the proper result; and it is to be noted that the apparent amount of alteration in the conditions is no measure of the amount of effect produced on the organism. For instance, none of the English breeds of sheep can be kept pure in France, the lambs of even the first generation lose vigour as the heat of the summer comes on, and the breed becomes absolutely degenerate. It is extremely curious that the force of inheritance which seems all powerful in England should give way so utterly under such a slight change of circumstances.

The method by which a breed was formed, combining the valuable qualities of the English sheep with a constitution fitted for the French conditions of life, is most instructive, and is a triumph of thoughtful and scientific breeding. The successful attainment of this end is due to M. Malingié-Nouel. He found that the offspring of a cross between a pure English ram and a French ewe inherit the desirable form of the sire, but, unfortunately, also his undesirable constitution. He accordingly paired a ewe taken from a border district, and therefore intermediate between two breeds, with a similar intermediate ram. He thus produced a sheep "combining the four races—Berry, Sologne, Merino, and Touraine . . . without decided character, without fixity, . . . but possessing the merit of being used to our climate and management."[3] It was now found that the lambs born of this mongrel ewe by purely-bred New Kent rams combined the English form with the French constitution, and transmitted this desirable combination to their offspring, and in this way the "Charmoise" breed was produced.

In this instance it seems as if the tendencies supplied by the ewe formed so discordant a combination that no strong tendency resulted for any of the French forms to appear, so that the form of the English ram was strongly impressed on the offspring. On the other hand, the *constitutional* tendencies coming from the mother's side were not discordant, but united in impressing the French constitution on the offspring. This case is instructive as establishing the possibility of an important kind of acclimatization, and as bearing on a somewhat exceptional phenomenon of heredity, namely, that when *both* parents exhibit a given character strongly, the offspring do not inherit it so surely as when one parent only is especially well characterized. Thus a successful breeder of laced Sebright bantams says,—"I am confident that those that are best laced frequently produce offspring very far from perfect in their markings, whilst those exhibited by myself which have so often proved successful were bred from the union of heavily laced birds with those that were scarcely sufficiently laced."[4] The class of cases just noticed is, moreover, of great interest as bearing on a form of inheritance which has been named "prepotency of transmission." When the offspring, instead of being intermediate between the parents, strongly resemble one of them, the latter is said to be prepotent in transmitting its likeness. The famous bull Favourite is believed to have had a prepotent influence on the short-horn race. It has also been observed with English race horses that certain mares have generally transmitted their own character, while other mares of equally pure blood have allowed the character of the sire to prevail.

In other cases a remarkable weakness of transmission of character is found to exist. A striking instance is given by Mr Brent.[5] It must be premised that the breed of pigeons known as "trumpeters" is characterized by a tuft of feathers over the beak, by a crest on the head, and by a most peculiar coo. Mr Brent crossed a trumpeter with another breed, and then recrossed the mongrels with trumpeters. But it was only at the fourth generation, when the birds had $\frac{15}{16}$ trumpeter blood in their veins, that the characteristic tuft appeared, and even then the peculiar trumpeting coo was absent.

It is frequently asserted that the male is prepotent over the female in transmitting certain characters. It has been shown,[6] however, that such rules do not hold good except

[1] *Principles of Biology*, 1864, No. 10, p. 242.
[2] *Proc. Roy. Soc.*, No. 297; *Brit. Assoc.*, 1870; *Lancet*, Jan. 1875, p. 7.
[3] *Jour. Roy. Agri. Soc.*, xiv. 1853, p. 214, translated by Mr Pusey.
[4] *The Poultry Book*, by W. Tegetmeier, 1866, p. 245.
[5] *The Pigeon Book*, p. 46.
[6] Prosper Lucas, *L'Hérid. Nat.*, tom. ii. l. ii. ch. i., and Gärtner, *Bastarderzeugung*, s. 264-266.

to a very limited extent, and in certain groups only. It frequently happens that a character existing in one of the parents is transmitted more powerfully to the offspring of the sex to which that parent belongs than to the opposite sex. The large and important subject of secondary sexual characters hinges entirely on this phenomenon. The resemblance between prepotency and sexual limitation becomes clear when we remember that where the offspring are of one sex it may be impossible to distinguish between these forms of heredity. The most interesting point connected with secondary sexual peculiarities in relation to the subject of breeds is, that they are sometimes found in domesticated animals whose nearest wild congeners show no such limitation of character. Thus in the sheep, the males of certain races differ greatly from the females in the shape of their horns, in the development of fat in the tail (in certain fat-tailed breeds), and in the outline of the forehead. These differences are interesting because, so far as we know, similar secondary sexual differences are not found in the nearest allied wild species of sheep. On the other hand, secondary peculiarities which originally distinguished the sexes are in some cases diminished or removed by domestication. Thus our improved breeds of pigs have to a large extent lost the formidable tusks of the wild boar. The existence of secondary sexual characters gives a striking illustration of another important law of inheritance. This law asserts that the age at which any character first shows itself in the offspring is the same as that at which it appeared in the parent. Now, secondary sexual characters—those, for instance, presented by the male sex—have apparently been developed by sexual selection, and this force can only be brought to bear on variations occurring in adult animals. If, then, the male offspring do not develop the selected peculiarities until they arrive at puberty, the age at which it appeared in their male parent, it is clear that they cannot differ from the female until the age of puberty arrives. And this is well known to be the case, for at an early age the sexes are usually undistinguishable by any secondary characters. (See *Descent of Man*, vol. i. chap. viii.)

The interesting form of inheritance exemplified by the transmission through the female line of diseases necessarily confined to the male sex has been already alluded to. This latency of male characters is clearly illustrated by what frequently occurs to old hens. It is well known that a large number of female birds, when old or diseased, partly assume the secondary male characters of their species. Waterton (*Essays on Nat. Hist.*) gives a curious instance of a hen which had ceased laying, and had assumed the plumage, voice, spurs, and warlike disposition of the cock. The opposite case of the assumption by the male of female characters is illustrated by the fact that capons sometimes acquire the sitting instinct of the hen.

The possibility of characters existing in a latent condition is of the utmost moment to the breeder, since upon it depends the possibility of reversion or atavism. Reversion is a matter of extreme importance to the breeder, for it is one of the serious hindrances to the progress of his art. Since the time of the famous Bakewell during last century, Leicester sheep have been bred with the most scrupulous care, yet grey-faced, black-spotted, or wholly black lambs occasionally appear. In this case the most careful selection has been necessary to battle against the tendency of the original colouring of the sheep to reappear. And in all cases of selection it is this tendency that has to be struggled against by the breeder. On this principle the gardener looks over his beds and weeds out the "rogues." Even from seeds gathered from the finest cultivated varieties of the heart's-ease (*Viola tricolor*), plants perfectly wild both in flowers and foliage are frequently produced. The proximate cause of any particular case of reversion is utterly obscure; but some of the general causes may be set down. It is frequently asserted that domestic animals or cultivated plants, when allowed to run wild, always revert to the original parent form of the species. This assertion appears to rest on insufficient evidence, and to be an exaggerated statement of what is known on the subject. Nevertheless some weight must be allowed to it. Pigs have run wild in various parts of the world, and have everywhere acquired the general characters of the wild pig, and the young have re-acquired the longitudinal stripes. This last character is interesting, since it is not in any way a direct result of the changed conditions of life, as the thicker bristles and increased size of the tusks might be supposed to be. Another well-established cause of reversion is *crossing*. The case is exceedingly striking when the offspring of a cross do not resemble any near progenitor, but throw back to very remote ancestors. In illustration may be mentioned the experiments on pigeons detailed in the *Variation of Animals and Plants under Domestication* (vol. i. p. 200). There can be but little doubt that all our domestic races of pigeons have descended from *Columba livia*, the wild rock pigeon; the common dovecot pigeons exhibit the coloration of the parent form, and the most purely-bred fancy breeds, when of a blue colour, often show these characteristic marks. One of the above-mentioned experiments consisted in pairing a "mongrel female barb fantail with a mongrel male barb spot, neither of which mongrels had the least blue about them." It appears that blue barbs are exceedingly rare, that the spot has been known as a pure breed for nearly 200 years, and that a white fantail throwing any other colour is almost an unknown occurrence; nevertheless the offspring from the above two mongrels were of exactly the same blue tint over the whole back and wings as that of the wild rock pigeon from the Shetland Islands. Moreover, every characteristic mark of the wild pigeon was repeated in their mongrel offspring. This experiment demonstrates in the most striking way the tendency of a cross to produce reversion. The same result was also obtained by pairing black Spanish cocks with hens of various white breeds. In this case the offspring reverted to the red colouring of *Gallus bankiva*, which may be safely ranked as the parent form of our domestic fowls. In these instances the offspring revert to a character originally possessed by the ancestors of both parents, and here the cross is in no way essential to the reversion; it merely acts as a disturbing cause (although, probably, no other equally strong disturbing power could be named). In these cases reversion to a character of any degree of antiquity may occur. In the other class of cases where the character to which the offspring revert is one given by a single cross with a distinct variety, the tendency to reversion becomes weaker in each generation removed from the cross, and may ultimately be obliterated. The length of time requisite to effect obliteration has formed a subject of discussion. The question can hardly be answered, but the fact that it has been asked shows at least that obliteration may in some cases be effected in a practically finite period. In other cases even characters gained in this way by a single cross seem incapable of extermination. Fowls have been known to exhibit a Malay character, due to a cross with that breed forty years previously.

Variability.—When in any case we find the offspring differing from the parent, we set it down at first sight as an instance of variability. But on the discovery being made that the peculiarities characterizing the offspring are derived from a remote ancestor, it can no longer be so considered, and must be attributed to reversion. Many cases of apparent variation are due to this cause. Thus Gärtner declares, and his experience is of the highest value

on such a point, that when he crossed distinct species of native plants that had not been cultivated, he never once saw in the offspring any new character; but that, from the odd manner in which the characters derived from the parents were combined, they sometimes appeared as if new. It appears, therefore, that the point at which the line of distinction is drawn between reversion and variation depends in many cases on the state of our knowledge of the subject. In some other points, also, the relations between inheritance and variation are extremely intricate and difficult to unravel. These two principles are often spoken of as opposed to one another. The following case shows that any definition of variability implying that it is necessarily equivalent to a breach in the law of heredity is incorrect. Some kinds of sheep and cattle dogs are congenitally almost destitute of a tail; and this Stonehenge attributes to the fact that under the old excise laws only those dogs whose tails had been removed were exempt from taxation; so that this mutilation was universally practised until the deficiency became hereditary. The production of a tailless breed of dogs must certainly be considered a case of variation, yet in this case it is not a *breach* of the law of heredity, but a remarkable instance of obedience to that law, that is to say, of the transmission of the effects of mutilation. In other cases external causes produce some constitutional or otherwise imperceptible changes in the parent, and these in being transmitted to the offspring become correlated with some external or *perceptible* alteration, and in this way new characters may appear. This is undoubtedly a true case of variation; nevertheless, strictly speaking it is due to the inherited effects of a cause acting on the parent. And it seems illogical to separate it in a radical manner from cases such as that of the tailless breeds of dogs. Considering, therefore, the great difficulty in which the subject is enveloped, it will be well to abandon theoretical considerations, and merely to state that characters at least practically new do undoubtedly appear in the offspring. In every group of organisms a degree of variability, sufficient to give material for the breeder to work on, probably exists. The Laplander knows and gives a name to each of his reindeer, though, as Linnæus remarks, "to distinguish one from another among such multitudes was beyond my comprehension, for they were like ants on an ant-hill." A still more striking case is that of the old Dutch florist Voorhelm, who kept above 1200 varieties of the hyacinth, and was hardly ever deceived in knowing each kind by the bulb alone. These cases are important as showing that, even in natural objects which appear identical to the unpractised eye, perceptible differences do exist. Man can effect nothing until some of his stock begin to vary in the desired direction. But horticulturists have found by experience that when any particular character is desired, the first step is to get the plant to vary in any manner, and to go on selecting the most variable individuals even though they vary in the wrong direction, for the fixed character of the species being once broken through the desired variation will sooner or later appear. The great number of races of many domestic animals and plants—for instance, of pigeons, sheep, wheat, &c.—demonstrates clearly their variability in many diverse characters. In other domestic animals, however, very few distinct races exist; yet we must not conclude that these animals have not varied. There are several causes besides that of an inherent want of plasticity which may have been at work. It will here suffice to allude to a few of them.

1. If any particular group has not been especially subjected to selection, the absence of distinct races in such a group is no proof of want of variability. This applies to asses (in England only).

2. If the breeder has not a large number of individuals to select from, the chance of the required variations occurring is very small. Hence animals kept in small lots do not form races (*e.g.*, sheep on small holdings).

3. If intercrossing cannot be prevented, it is obvious that any variety which may appear will have no chance of being perpetuated, but will be diluted down to the normal type. This applies to cats, which, from their wandering and nocturnal habits, cannot be paired.

It may appear a truism to say that every variation must have a distinct cause, but it is a truism very often overlooked. The case of twins, each born with a peculiar crook in the little finger, is instructive, for here the conclusion is irresistible that the same definite, though unknown, cause produced the mal-formation in the two children. This case may also serve to illustrate the extreme obscurity in which the causes of any given variation are hidden, and the great difficulty of investigating them. Some general causes which induce variability may, however, be set down.

There appears to be no doubt that organisms subjected to the unnatural and changeable conditions implied by domestication are more variable than those living in a state of nature. Thus monstrosities are comparatively frequent among domestic animals and plants.[1] Domestication causes a number of changes in the condition of life; it is therefore of interest to determine which of these are the most important. Contrary to what might have been expected, change of climate is not an important cause of variation. This is repeatedly shown by A. de Candolle in his *Géographie Botanique;* and a change to a more genial climate is certainly not necessary, for the dwarf kidney bean, which is often injured by our spring frosts, and the peach, which requires the protection of a wall, have varied much in England. (See ACCLIMATISATION.)

In some moths the colour of the perfect insect is affected by a change in the food of the caterpillar, but there seems to be no evidence that this cause has been active in inducing variability in our domestic races. On the other hand, *excess* of food is probably an important cause of variability. This view was held by Andrew Knight, and the same idea is expressed in the following remark of a "great raiser of seeds:"—"It is a rule invariably with us, when we desire to keep a true stock of any one kind of seed, to grow it on poor land without dung; but when we grow for quantity we act contrary, and sometimes have dearly to repeht of it."[2] Nevertheless it appears that many of the best varieties of fruit have not been produced under cultivation. Thus it is asserted that some of the finest French pears were originally found growing wild, and this was the case with an English variety of apple. The most interesting fact connected with changes in the conditions of life is that the results of such changes are capable of accumulation. It is this peculiarity that accounts for the fact that when new flowers are first introduced into our gardens they do not vary. Thus the Swan River daisy did not break from its original colour until it had been subjected to seven years of high culture. Many facts might be given showing by what slight changes of habitat the health and general development of animals and plants may be affected;[3] but with these cases we are not especially concerned. (See ACCLIMATISATION.) The causes, however, which induce an unstable condition of general variability are of great importance to the breeder. Of the causes not already touched on the most important is intercrossing. In considering variations under this aspect no attempt will be made to distinguish from true cases of variation the cases in which new characters are simulated by combinations of old ones. In the first place, it is probable that organisms propagated by *sexual* reproduction

[1] J. Geoffroy St Hilaire and Moquin Tandon.

[2] Quoted in *Var. under Domes.*, ii. p. 257.

[3] See *Var. under Domes.*, vol. ii. ch. xxiii., on "The Definite Action of the Conditions of Life."

are usually the most liable to variation. For here the offspring has a double chance of being influenced by circumstances affecting the parents; and by the concentration of a double set of tendencies into one individual, a better chance is given for the origin of variations produced by combinations of ancestral characters. In the same way, to a certain extent, a cross with a distinct variety produces a disturbance or loss of equilibrium in the reproductive system from which a tendency to the production of variations results. Thus Gärtner asserts that seedlings from *Dianthus barbatus*, when crossed by the hybrid *D. chinensi-barbatus*, were more variable than those raised from this latter hybrid fertilized by the pure *D. barbatus*. Max Wichura insists strongly on an analogous result in the case of willows; and Kölreuter says that to obtain an endless number of varieties from hybrids they should be crossed and recrossed.

Some peculiarities in our domestic races are to be attributed to the inherited effects of habit and of disuse. Splints and ring-bones on the legs of horses appear to be certainly hereditary; and veterinary surgeons agree in pronouncing these growths to be the result of travelling on hard roads, and of the horses being shod. The effects of disuse are clearly shown in the skeletal characters of our domestic races. These effects are well marked in tame birds, which are necessarily prevented from exercising their wings in flight. Thus in the domestic duck the crest of the sternum is less prominent, the furculum, coracoids, and scapulæ are all reduced in weight relatively to that of the whole body; the bones of the wing are shorter and lighter, and the bones of the leg longer and heavier in comparison with the same bones in the wild duck. Closely connected with this class of facts is the subject of rudimentary organs. In organisms living in a state of nature the constant pressure of the struggle for existence tends to keep useless structures in a rudimentary condition. But domestication, in removing this pressure, does away at the same time with the principle of economy of growth; and accordingly, we find that organs rudimentary in a state of nature become developed under domestication. Thus cultivation has made true branches out of the thorns or rudimentary branches of the wild pear. Again, the rudimentary fifth toe on the dog's hind foot becomes in some cases considerably developed, and forms the "dew-claw" of a few large breeds.

Correlation has probably played an important part in modifying domestic races; for in selecting a given character man has frequently perpetuated many other peculiarities correlated with the first.

Finally may be mentioned the curious phenomena of "analogous variation." This term is applied to those cases in which varieties of one species resemble distinct but allied species. Where this occurs it is probably due to the two forms having originated in a common progenitor, so that modifying causes evolve similar varieties in the two cases because of the similarity of the material which these forces have to act on. Analogous variation is therefore, properly speaking, a branch of the subject of reversion, and once more points out the close connection existing between the latter phenomenon and variability.

In purely bred fowls of many races, birds may occasionally be found closely resembling the *Gallus bankiva*. Here the case is one of simple reversion, and has already been alluded to. The production of spangled sub-breeds of Hamburgh, Polish, Malay, and Bantam fowls is not an obvious case of reversion to a known ancestor. It may be due, however, to descent from the parent form of the Gallinaceæ, considering the frequency of spangled markings throughout the order.

Selection.—Selection may be defined as the process by which the procreators of each fresh generation are chosen out of the preceding one. But with reference to the formation of our improved breeds something more than this is meant by the term. The modern development of the art, which has been distinguished by Mr Darwin as *methodical selection*, always implies that the breeder has before his mind an ideal form,—a model on which he attempts to mould his strain. To be successful in this respect a man must not only possess in the highest degree the powers of discrimination, enabling him to determine which individuals are tending in the right direction, that is, which most nearly approach his ideal, but he must be able to decide, in the most judicious manner, as to which of his selected individuals ought to be paired together. The subject, therefore, falls naturally into two divisions—(1) the discrimination of individual differences, (2) the arrangement of the pairing.

1. *Discrimination of Individual Differences.*—The extremely fine powers of perception and the great patience required by the breeder might be illustrated by numerous instances. Sir John Sebright is said to have sometimes spent several days in weighing the rival merits of five or six birds. In Germany the merino sheep farmers do not even trust their own judgment, but employ professional "sheep classifiers" to select the best of the flock for breeding purposes. Not merely outward form, but internal and constitutional peculiarities have been carefully attended to by breeders. Thus, Bakewell (the first true methodical breeder of whose proceedings we have any knowledge) bred almost entirely for the early maturity and fattening qualities of his strain; and again, in the improved short-horn breeds, the masses of internal fat or tallow have been increased to an almost incredible extent.[1] Professor Low states,[2] as an instructive instance of the limits that should be put to the exaggeration of any one point, that even the great Bakewell appears to have made this mistake in causing a useless accumulation of fat where it was not needed. It seems that the fat mingled less with the lean than even in the old breeds, and that it spread in layers under the skin, forming cushions of fat. He quotes a writer who observes that, having with great difficulty formed a race of cattle that would "make fat," Bakewell left his successors under the necessity of producing a breed that would "make lean." The same kind of error was at one time committed with the improved short-horns, whose progenitors were pre-eminently good milkers; here the breeders, by attending exclusively to other qualities, have in some cases injured the milking powers of the race. Youatt is convinced that this loss is not necessarily correlated with rapid feeding qualities.[3] He asserts that by careful selection a strain may be obtained (and this has, in fact, been effected) in which the cows are first-class milkers, and when dried fatten quickly and well.

In spite of these warnings against exclusiveness and exaggeration, it should be remembered that the difficulties of selection are greatly increased by attention to several points at once. An illustration of this may be taken from the less important art of fancy breeding. An eminent fancier in speaking of the almond tumbler pigeon (a breed having five points, viz., plumage, carriage, head, beak, and eye), remarks that "there are some young fanciers who are over covetous, who go for all the above five properties at once; they have their reward by getting nothing." Mr Darwin observes, "We may smile at the solemnity of this precept, but he who laughs will win no prizes."

It should be remarked, however, that "fancying" is not governed by rules identical with those which regulate breeding for economic purposes. The fancier often has to strive after extreme abnormal development, amounting to monstrosity; it has often been remarked that he will not tolerate anything short of this extreme divergence. On the other hand the economic breeder is prevented by solid monetary considerations from being misled, to any great extent, by fashion. Hence, instead of the wide differences observable in "fancied" animals, we find a remarkable uniformity in certain characters among many of those bred for use. Thus all the improved races of the pig closely resemble each other in their shortened legs and muzzles, their large hairless bodies and small tusks. Well-bred cattle of several distinct races exhibit a similar convergence of character.

2. *Arrangement of the Pairing* (including crossing).—We have already alluded to the remarkable case in which it seems an advantage to the offspring that one parent *only* should possess the desired quality in an especial degree. This may be considered an extreme case, yet it bears some relation to the principles on which breeders usually regulate the arrangement of the pairings. Generally speaking, individuals having certain points peculiarly well developed are matched with those excelling in other directions. It is probable that a physiological law which would formulate the exceptional cases above mentioned would also favour the more common practice

[1] Youatt, *Cattle*, 1834, p. 227, *et seq.*
[2] *Domesticated Animals*, 1845, p. 378.
[3] *Op. cit.*, p. 239.

now under consideration. For it would allow the transmission of qualities from either parent, undisturbed by the influence of the other, to the offspring. In this part of his work the breeder once more finds occasion for the utmost skill and judgment; but so difficult to formulate are the fruits of his experience that he often seems guided in his choice by instinct rather than by reason. Every new breed must originate in a few individuals possessing some special peculiarities. Therefore, nearly-related individuals must at first be matched; in other words, close "in-and-in" breeding must be practised, or the race cannot be "fixed." In consequence of the uniformity obtained by pure breeding, characters otherwise unimportant become valuable as marks of purity of race. Thus the dark red colour of the Devon cattle becomes a criterion of "blood."

The advantages of in-and-in breeding have been insisted upon by the improvers of our domestic breeds, and some of them have declared that no ill results follow from the practice. But in spite of this assertion it is generally admitted that degeneration either in constitution or in other ways does ultimately ensue; so that at any cost the breeder is absolutely compelled to admit blood from another family or strain of the same race. In speaking of this necessity in the case of sheep, Youatt says that the breeder will choose "a ram from a soil and kind of food not dissimilar to his own, . . . with points as much resembling his own sheep as may be—quite as good as those in his own flock—superior if possible in some points, inferior in none." But in opposition to Youatt it may be argued, from the practice followed by some great poultry breeders, that animals having the same physical characters, but which have been kept under different *conditions*, ought to be selected for crossing. By this means tone and vigour are infused into the stock without materially altering its character. In other cases a different plan has been followed. For instance, Colling (for what purpose is not clear, on account of the secrecy in which he carried out his art) crossed his short-horns with a distinct breed—the Galloway. He thus produced a sub-strain or family, called in reproach the "Alloy," but possessed of great merits, which, by recrossing with short-horns, became quite equal to the pure breed,[1] and produced animals which sold for enormous prices. This method of making one "violent" cross, and trusting to subsequent recrossing with the pure parent form (together with long continued selection), has sometimes been followed where some especial quality is required. Lord Orford's well-known attempt to infuse pluck into his greyhounds by means of a cross with a bull-dog is a case in point. Stonehenge records a carefully-observed experiment of the same kind, which shows that the objectionable form of the bull-dog can be thoroughly eradicated even in four generations. In other cases a cross with a distinct variety is effected with the object of forming an intermediate race which shall transmit its characters.

Crossing.—An injudicious exaggeration of certain qualities, as in some cases before alluded to, has taken place in breeding long-woolled sheep. Here the fleece has been almost exclusively attended to, and the quality of the carcase allowed to deteriorate. No doubt, an improved breed remedying this evil might have been formed by selection, but this process would have been slow and extremely difficult; and, fortunately, there existed the readier method of forming a cross-breed race combining the desirable characteristics of both varieties. Messrs Druce and Pusey[2] have pointed out the great increase of profit yielded by a cross between the long and short-woolled sheep The following table gives in the first column the number of Cotswolds, Southdowns, and sheep of a "cross breed" intermediate between them, which a given area will support; the second gives the total value of fleece and carcase in each case for the number of animals given in the first column:—

Cotswold	100	£496
Southdown	120	488
Cross-breed	115	597

Crossing has, in fact, entered largely into the formation of nearly all our improved sheep.[3]

In some cases the offspring of a first cross between distinct species possess valuable qualities, but owing to their sterility an intermediate *race* cannot be formed. If, however, the combination is valuable the cross may be repeated at will. The breeding of mules is a familiar example of this method. In the same way cross-bred cattle, which though not sterile are yet incapable of transmitting their valuable qualities to their offspring, are bred for the butcher by a repetition of the first cross.

Some of the more important points in connection with methodical selection and the modern art of breeding have now been briefly indicated. The results obtained have been truly astonishing. Lord Somerville graphically remarked that the modern sheep-breeder appeared to have "drawn a perfect form and then to have given it life." These extraordinary improvements have been effected almost within the last century; and it may be objected that because selection as now practised is of modern date, the differences which characterize many races of great antiquity cannot have been produced by man. This objection, however, is not valid, for it can be shown that an unnoticed and therefore unrecorded cause of modification has long been in existence. This important agent has been named "unconscious selection;" it is illustrated by the following case. In speaking of two flocks of the New Leicester sheep possessed respectively by Messrs Buckley and Burgess, Youatt remarks that "both of their flocks have been purely bred from the original stock of Mr Bakewell for upwards of fifty years. There is not a suspicion existing in the mind of any one at all acquainted with the subject, that the owner of either of them has deviated in any one instance from the pure blood of Mr Bakewell's flock; yet the difference between the sheep possessed by these two gentlemen is so great that they have the appearance of being quite different varieties."[4]

Now we may feel sure that neither of these breeders intended to alter the character of his flock, he merely strove to produce the best possible New Leicester sheep and selected those which approached his ideal most closely. Yet owing to slightly different standards of excellence having been unconsciously aimed at in the two cases, the important results pointed out by Youatt arose. It is an exceeding remarkable fact, that changes so small as not to be perceived by the trained eye of the modern breeder may by accumulation produce obvious results in the short space of fifty years. And if such changes may occur unnoticed under the supervision of men keenly alive to the possibilities of change, a far greater field for this kind of modification must have been offered before any such knowledge was general. An unperceived divergence of character will arise whenever men, actuated by some vague belief in heredity, begin to select the best individuals, roughly speaking, for reproductive purposes. Each man will unconsciously take a standard of excellence slightly different from his neighbours, and thus his strain will imperceptibly begin to differ from theirs. Now there can be no doubt that an amount of selection sufficient for this purpose must have been practised from a very remote period. Youatt, after an examination of the passages in the Old Testament bearing on the subject, asserts that some of the best principles of breeding were then understood. The antiquity of breeding is also proved by certain passages in ancient Chinese encyclopædias.

The ancestors of nations at present civilized must have passed through stages in which they resembled the savages of the present day; therefore it may fairly be assumed that customs which are found among lowly developed savages are of great antiquity. Now few races are more barbarous than the Australians, yet even they take pains in the breeding of their dogs, matching the finest together and providing good food for the mother in order that the young may be well nurtured. From a large body of similar evidence there can be no doubt that a degree of selection sufficient for the development of unperceived divergence has been

[1] Low, p. 391. [2] *Jour. Roy. Agri. Soc.*, xiv., 1853, p. 214.
[3] See Mr Spooner's excellent paper on "Cross-Breeding" in the *Jour. Roy. Agri. Soc.*, vol. xx. pt. ii.

[4] *The Sheep*, p. 315.

practised from exceedingly ancient times. The results produced by prolonged selection of this kind may be estimated in various ways. For instance, although it is certain that the pointer originally came from Spain, no such breed exists there at the present day. So far as is known no efforts have ever been made to modify the pointer; but every one has wished to possess as good dogs as possible, and by an unconscious consensus of opinion, the desire for improvement has resulted in a slow progressive change in a certain direction. But the amount of divergence produced by long-continued selection may be illustrated more forcibly by general considerations than by special instances. The fact that the progenitors of many cultivated plants and domestic animals cannot with certainty be determined points out the great divergence from the wild parent form that has been effected under domestication. The genus *Auchenia* may serve as an illustration. There are four forms in this genus—the guanaco and vicuña, found wild, and undoubtedly distinct species, and the llama and alpaca, known only in a domesticated condition. Most professed naturalists have looked on all four forms as specifically distinct, and have made the assumption that the wild llama and alpaca have become extinct. But Mr Ledger appears to have proved conclusively[1] that the llama is the domesticated descendant of the guanaco, and the alpaca that of the vicuña,—so that a large amount of divergence must have been effected in this case. And as we know that careful selection was anciently applied to these animals, there is nothing inconceivable in such a transformation having been effected. The power of long-continued selection is well shown by the fact that, in domestic animals and plants, the parts or qualities valued by man have been most modified; thus the sheep has been prized during many ages for its fleece, the horse for its strength and fleetness, and, accordingly, we do not find breeds of sheep differing from each other in strength and fleetness, or breeds of horses distinguished by the properties of their hair, but on the contrary both animals have produced races characterized by differences in the qualities for which they are valued. The same law is even more clearly demonstrated by plants under cultivation. In the radish, which has been esteemed exclusively for its root, it is the latter that differs in the several varieties, while the flowers, seed, and foliage are almost identical in all. Again, the varieties of the gooseberry differ much in their fruit, but hardly perceptibly in their flowers and organs of reproduction. In some cases structures neglected by man have varied by correlation; but allowing for this exception, they may be said to have escaped the effects of selection, and accordingly to have remained stationary, while the selected qualities have gradually improved.

In attempting to frame an answer to the question—How much has man actually effected? it will be well first to estimate the amount of modification which may be claimed as his work, and then to measure the efficiency of the agents by which these results are believed to have been effected.

(1.) Organic beings resemble each other in descending degrees, so that they can be classed in groups under groups,—classes, orders, genera, &c. The doctrine of evolution gives life to this arrangement and makes it truly a "natural" classification,—the idea of different degrees of community of descent being added to that of arbitrary classification by community of characteristics. Thus it happens that the number and distinctness of the genera contained in a natural family become to a certain extent a gauge of the amount of divergence which the modifying causes of nature have produced, since the time when all the genera were united in the parent form of their family. And by a similar method we may estimate the amount of divergence that man has effected. For instance, there can be no doubt that all the varieties of the domestic pigeon are the descendants of the rock pigeon, and have sprung up under the care of man during the long period of time that has elapsed since their wild ancestor was first domesticated. These varieties amount to more than 150 in number; and there can be no question that, supposing them to be found wild, they would be grouped under at least five distinct genera,—so great are differences existing among them. This instance gives some idea of the marvellous amount of modification that may arise under domestication.

(2.) Are the powers which man possesses of producing modification sufficient for the work assigned to them? It will be well to set down the assumptions which may fairly be made in connection with this point.

First, the labours of the great breeders teach us what enormous changes can be effected in the short space of one man's life; and we know that the essential principles involved in the process were anciently known and followed.

Secondly, we may feel certain that great divergence of character is unconsciously produced during long continued selection of any kind; and we know that some kind of selection must have existed from remote periods. Logically considered, therefore, the possibility of almost any degree of divergence having been effected turns in great measure on the question of the antiquity of selection.

It is therefore important to note that an indirect kind of selection must almost necessarily be coeval with domestication. For this can be shown to be the case with tame animals possessed by the rudest savage, who does not regulate their increase in accordance with even the vaguest belief in heredity. In each litter of puppies, for instance, some would necessarily be destroyed, for their master would be unable to preserve all the young ones which were produced. He would certainly not save those which were small, feeble, or deficient in any valuable quality. The finest in each generation would then be preserved, merely because it was believed that they, individually, would be useful, and not with any idea of "breeding." Nevertheless, it would indirectly follow that the superior individuals in each generation would, as a rule, form the progenitors of the next one; that is, a kind of indirect selection would arise. If then we can be sure that domestication, in some form, has existed from remote times, we may feel tolerably certain that the above-described rude form of selection must be of nearly equal antiquity. Apart from the direct proofs on this head which we possess in the remains of the prehistoric period, there is a high antecedent probability in favour of the extreme antiquity of domestication; for it is certain that tame animals are of great use to savages, and the wild progenitors of many of our domestic creatures are rendered tame with ease. This is the case with wild dogs, pigs, cattle, ducks, &c. In the case of vegetables, it appears that, in times of scarcity, savages devour almost any berries or leaves which they can obtain, often suffering terribly in consequence; and in this way plants at all superior in nutritious qualities would assuredly be discovered. We may, therefore, conclude—(1), that the domestication of animals and the culture of plants date from exceedingly remote antiquity; (2), that a certain amount of selection must have been nearly coeval with domestication; (3), that some degree of divergence of character must almost necessarily have accompanied selection; and (4), that, consequently, the large amount of modification claimed to have been produced by man is a conceivable and credible result. (F. D.)

BREGENTZ, the ancient *Brigantia*, capital of the circle of Vorarlberg, in Tyrol, stands on a hill at the S.E. end of the Lake of Constance. It has an old castle, two convents, and an orphanage. Silk and cotton are manufac-

[1] *Bull. de la Soc. d'Acclimat.*, tom. vii., 1860, p. 457.

tured, and it carries on an active transit trade. It was long the seat of a Roman garrison, and in the Middle Ages it gave the title to a powerful family of counts, whose territory passed to Austrian possession in the 16th century. In 1646 the town was captured by the Swedes; and in 1850 it gave its name to a treaty by which Austria, Bavaria, and Würtemberg formed an alliance against Prussia. Population in 1869, 3686.

BREHON LAW, the law of Ireland previous to the Conquest, and of some communities of the Irish down to the 17th century (from *breitheam*, genitive *breitheamain*, a judge; root, *breith*, a judgment; compare *Vergobretus*, "*vir-ad-judicandum*," Cæs., *De Bell. Gall.*, i. 16). Three volumes of these laws, comprising the code called the *Senchus Mor*, alleged to have been revised by St Patrick, have been published by a Royal Commission appointed in 1852, and other portions in the second series of O'Curry's *Lectures on the Materials of Ancient Irish History*, edited, with a learned introduction, by Dr W. K. Sullivan in 1873. The antiquated and often obsolete language both of the original text and of the interlined glosses, coupled with the fact that portions of both are cited in compilations considered not later than the 10th century, are arguments for their acceptance as fragments of a primitive system unmodified by Anglo-Saxon, Danish, or Norman influences. The Roman (or civil) law is hardly traceable in them, except as regards ecclesiastical affairs, and that *sub modo* only. From the first-mentioned cause also, the provisions are often obscure and sometimes unintelligible; but enough appears to indicate the general nature and much of the details of these laws.

As compared with the collections known under the generic title *leges barbarorum*, they are remarkable for their copiousness, and furnish a striking example of the length to which moral and metaphysical refinements may be carried under rude social conditions. They present a state of society such as may be conceived to have existed under the older manorial organization, when the land was to a greater extent "folk"-land than "boc"-land, and comprised commons of tillage as well as of pasture. This kind of occupancy entailed annual repartitions of the tillage, recalling the usage of the ancient Germans (Cæs., *Bel. Gall.*, vi. 20), and of which, as practised on a minor scale in Ireland in 1782, Sir Henry Piers has given an account in his description of Westmeath (Vallancey, *Coll.*, vi. p. 115). Traces of such repartitions survived under the name of Rundale (Irish *ranndach*, "partire") in the Highlands of Scotland and in some parts of the West of England till recent times (Maine, *Early Inst.*, p. 101). There is no evidence, however, in the Brehon code, as now published, of merely family occupancy, in which one household living together, or even one village community, enjoyed the land and its produce in common, although such an origin may be theoretically conjectured for the institutions described. The social unit comprised separate families and households numerous enough to occupy a *crich* or *quasi* manor, within which existed a court and complete system of primary social organization. In each of these, mensal lands were set permanently apart for the chief, and means existed by which portions of the common land could, within certain limits, be acquired in severalty by individual owners. The *crich* formed portion of the *tuath*, or *quasi* barony, one or more of which constituted the *mor tuath*, or petty kingdom, equivalent to a county or several counties, governed by a *ri* or *regulus*, who, in theory at least, bore allegiance, through superior *reguli*, to the monarch. The grades of rank were numerous, but the distinctions of wealth which grounded them appear very arbitrary. The upper classes were all "Aires." To be eligible to the *aire* grade, the freeman should possess, besides a certain amount of wealth in cattle, a prescribed assortment of agricultural implements and household goods, the meagreness of which exemplifies the slow progress of the arts of life in early states of society, and he should have a house of given dimensions, ranging from 17 to 27 feet in length, and containing a given number of compartments. The houses were of timber and wattle-work, surrounded by open spaces of prescribed extent for each class. The lower limit for this space was the distance to which the owner seated at his door could throw a missile of given weight; multiples of that distance determined its extent for the higher classes. Tacitus has noticed a like custom of keeping clear spaces round the several dwellings among the early Germans; and this regulation has probably contributed to retard the progress of the early Irish out of pastoral and agricultural into civic habits. There was a serf and slave population, who were designated *ernaans*, as representing the earlier Firbolg and Pictish colonists, who did not enjoy these privileges, except by the process of becoming *fuidhirs* or tenants of the separate lands of the nobles, who called themselves *Gaidel*, or Gael, and claimed a different descent. Besides these tenants, or "feuers," there were dependants called *ceilés*, who stood to the wealthy classes in a relation resembling that of the *clients* of the Roman commonalty to their patrons. Both they and the *fuidhirs* owed suit and homage to their *flaths* or lords, as well as services and rents in kind and in refections. The food-rents, *biadh*, corresponding to the Anglo-Saxon *feorme* (whence "farmer"), were supplied both at the residences of the chiefs and at the tables of their tenants, whence originated the customs of *coyne* and *livery* of later times.

The use of coined money was practically unknown, and the unit of value (*sed*, *seota*, "assets") was the cow. The *ceilés* appear to have been attached to their lords by largesses, or "commendations" of cattle which they used in their own tribal lands. It is in the *fuidhir* class that a law of tenure of land originated, and possibly in these relations we may discover the rudiments of a partly-developed feudalism. The *fuidhir* is, in the theory of the native etymologists, the *fo-tir* or "land-underling," as one who holds land of another. The rules regulating these several kinds of enjoyment of the land are peculiar to the Brehon code, and, as may be observed of all its provisions, are extraordinarily minute, being designed to fix all rights and liabilities, under every probable state of circumstances, in values numbered, which may be one cause for the slow social progress made under their operation. For each supply of cattle to the *ceilé* a definite return to the *airé* is fixed to the end of seven years, when the property vests in the *ceilé*. But the supply should not exceed fixed limits if the recipient would preserve his *status* as a freeman. The *fuidhir*, or base tenant, was bound to larger returns in rent and services, and the lord might, on violation of the tenant's engagements, resume the possession of the land; but it would appear that during the *fuidhir's* occupation he could not be otherwise disturbed without a measure of compensation. On the death of the *ceilé* or of the *fuidhir*, a *quasi* heriot was payable to the lord.

The succession to the territorial headships was elective within hereditary limits; the succession to tribal rights of occupancy, and individual rights of ownership in the separate hereditaments acquirable by individuals, was hereditary. The law of *distribution* of a deceased person's property is very minute in its provisions, though obscure, owing to the technical description of the classes and persons entitled; but it appears to have contemplated divisions *per capita* and not *per stirpes*. The law of *marriage* is remarkable for the variety of irregular relations which it appears to sanction, and for its careful protection of the separate pro-

perty of the irregular as well as of the lawful wife, both during cohabitation and on separation, which appears to have been frequent. The lawful wife seems to have had no other protection against the introduction of the "adaltraich" wife than the withdrawal of her separate property, in addition to certain mulcts payable to her on the occasion. She possessed independent rights of alienating a portion of her separate property, and could, to some extent, control the rights of alienation of her husband. The looseness of the marriage tie evidenced by these laws was one of the evils calling for reform alleged by the Irish prelates in their letter moving Pope Alexander III. to ratify the grant of the island made by Adrian IV. to king Henry II.

The practice of putting out the children of the wealthier classes to be nursed and educated may have contributed to make such relations less incompatible with domestic peace. The law of *fosterage*, of which few if any recognizable traces, outside the law of apprenticeship, have survived elsewhere, provides for the external nursing and educating of the children of the upper class by poorer members of the community, who, besides the fosterage-fee received with the infant, had a claim on the foster-child for support in old age. The fostering began from infancy, and terminated, in the case of daughters, at thirteen, and of sons, at seventeen years of age. A certain amount of instruction should be imparted. Girls of the less wealthy class should be taught to use the handmill (*quern*) and sieve, to bake, and to rear young cattle; those of the higher class to sew, cut out, and embroider. The boys should learn kiln-drying and wood-cutting, and those of the upper class chess-playing, the use of missiles, horsemanship, and swimming. The lawful food for all was porridge. Their clothing, besides the nursing clothes supplied by the parents, was according to their status, from sober coloured stuffs for the children of the less wealthy to scarlet cloth and silks for the children of those of the rank of king. Provision was made for the necessary correction of the pupil, with mulcts for excess. During the pupilage, the foster-father was entitled to all compensation for injuries to his charge, and liable to all mulcts for their offences. If the child died in its pupilage, another might be sent in its place. If returned before the completion of the term, or imperfectly educated, the foster-father should refund. The fixing of the proportionate amounts due in the several cases gives rise to much minute regulation. The law of *military service* like the others, was based on a system of fines leviable for non-attendance and even for desertion in the field. To what has been said on the land-law it may be added that public contributions were leviable for the repair of roads and bridges, and the maintenance of the chief's or king's fortresses; and that each community had a public mill, fishing-net, ferry-boat, &c., besides such objects of this kind as were possessed in severalty by the wealthier members. There was also a law of waifs and strays, and of wrecks of the sea, with provisions for the entertainment of shipwrecked seamen at the common charge of the district entitled to the distribution of the wreck. There is little mention of testamentary disposition; and from the language employed, a Roman origin may be probably surmised for it. To counterpoise the excess of privilege incident to the possession of wealth, the mulcts payable for misfeasances and nonfeasances of all kinds were graduated in the interests of the poorer classes. Crime and breach of contract might reduce from the highest to the lowest grade.

As regards the law of *contracts* generally, the disabilities arising from tribal partnership, infancy, imbecility, coverture, and obligation to the lord give rise to many exceptions and qualifications, the general rule being that acquiescence, after notice, by the parties jointly interested, or standing in relations of protectorship, has the effect of validating what would otherwise be void. Distinct periods are limited within which the parties entitled to disagree may avoid the bargain; and, in all cases, a *locus pœnitentiæ* of twenty-four hours is annexed to the oral agreement, within which time either party may rescind it. The nature and effect of a *warranty* on sale appears also to have been understood and provided for; and frequent reference is made to the cases arising on unsoundness, latent or supervening. There are some traces of a law of the *market*, but how far, if at all, it qualified the ordinary rules of contract, does not appear. The *Aenachs*, or great fairs, were held at distant places and at long intervals of time. Various immunities are given to the persons frequenting them; and a violation of some of the necessary provisions for securing the peace and decorum of the meetings was exceptionally punishable with death, while almost every other offence might be condoned by a pecuniary payment. A highly interesting account of one of these great assemblages, which was held triennially at Carman, near Wexford, is given in a tract translated in the 2d series of O'Curry's *Lectures*, where, among the various classes resorting there for amusement and traffic, mention is made of Greek merchants bringing commodities for sale. The laws themselves give little intimation of their own origin or sanctions. They appear to have undergone no substantial changes from time immemorial; but some evidence exists of local law-making authority exercised at meetings of the freemen of the *crich*, subject to revision by some higher authority, and one of the objects of these fairs or *comitia* was to publish such enactments as well as the general body of the laws and customs from time to time. The law of *torts* regarded all offences, with the nominal exception of murder, as condonable by fines until the offender and those liable for him could pay no more, when the defaulter lost his *status* and fell into the servile class. For some of the offences of the individual, the *finnê* or family were responsible; for others, particular sureties. Whether this system of *quasi* frank-pledge did not extend to breaches of contract, as well as to cases of non-feasance, misfeasance, and breaches of the peace, appears uncertain. The scale of mulcts for the several sorts of homicides, wounds, and personal hurts, is in outline the same with those of the other western European nations; but, in addition to their definite fine of so much for such and such a lesion or bruise, it provides by rateable deductions for excusatory circumstances of intention, knowledge, contributory negligence, accident, and necessity, all of which are considerable refinements on the contemporaneous systems of the Continent. The penalty of death for murder was of ecclesiastical introduction, and, like the law ordaining the payment of tithes, appears to have fallen into desuetude before the Conquest. Chief Baron Gilbert, in Dwyer's case (Gilb., *Ev.*, vol. i. p. 9) has an observation apposite to the state of society disclosed by this system of measured mulcts and mutual suretyship, in treating of the state of Britain before murder had become punishable with death under the later law of Canute:—

"It is not very hard to conceive how the kingdom was maintained by *pecuniary mulcts* only; for in those days every man was put in the *Decenna* (tything); and if found wandering three days out of the *Decennary*, he was taken up and imprisoned, and he was presently to abjure the kingdom, or else he lay at the mercy of every one that could lay hands on him. And if any offence was committed in any of the *Decennaries*, if the party was brought to answer, he was obliged to pay his fine for his offence, or he was *imprisoned* for ever; and, if he fled, the *tything* was answerable for his fine or mulct to the king. So that by this discipline men were put under a necessity of being innocent, or paying a grievous fine, or being totally deprived of the conversation of mankind. And the laying of the fine on the tything, in case the offender fled, made it the interest of every man to bring the offender to light, and made it exceeding difficult to conceal a theft or a murther."

Imprisonment, among the Irish at the period of these laws, does not appear as detention in a common gaol, but as a personal fettering of the culprit; and some of their subtlest distinctions concern the liability of the person bound to provide the fetters, in case of the culprit's escape. It has been suggested with much appearance of reason, that refinements of this kind, *inter apices juris*, with which the Brehon law abounds, are rather exercises of the writer's ingenuity in framing suppositional cases illustrating classes of abstract rules than evidences of any actual application of law to the particular subjects. Such are the law of the measure of damages for injuries by bees, by cats, by the hunting hound, by traps for game, &c., all which are elaborated to a pedantic nicety. Of the *courts* in which these laws were administered we have but an imperfect view. The primary local tribunal was a *quasi* court baron, called the *Airecht*, composed of freemen of a certain status. The inferior classes were *écoma airechta*, that is, "impares curiæ." The office of Brehon in the court is very obscurely indicated. The stays and imparlances (*anad, esain, dithim*), &c., incident to the process of bringing causes to final judgment, and the fact that damages were, in all cases of ordinary occurrence, assessed beforehand by specific rule, gave repeated opportunities for settling out of doors. There were professional advocates and means of carrying the case to courts of higher jurisdiction, but how these were constituted does not appear; but mention is made of several gradations from the *airecht urnaidh* (sheriff's *tourns?*) to the *cul-airecht*, or ulterior court, which indicates some resort by way of appeal. Their rules of *evidence*, in addition to the testimony of the eye, admitted, in questions of title to land, that of the ear, *cluais*, or general report, and *laidh* (*cantus*) or history in the form of a poem publicly recited (a remarkable example of practical functions belonging to the office of a bard) as well as the evidence of landmarks or mearing stones. These, it seems (O'Curry, 2d series, Sullivan, Introd., clxxxvii.), should be sunk under the surface, as Martin in his account of the Western Isles of Scotland (p. 114) has described:—

"They preserve their boundaries from being liable to any debates by their successors, thus. They lay a quantity of the ashes of burnt wood in the ground, and put big stones above the same; and for carrying the knowledge of this to posterity, they carry some boys from both villages next the boundary and then whip 'em soundly and tell it to their children. A debate having arisen between the villages of Ose and Groban in Skye, they found ashes as above mentioned under a stone, which decided the controversy."

This gives countenance to the tradition that, prior to the reign of Aed Slaine in the 7th century, there were no fences in the country, but all was open save the walls and mounds surrounding dwellings. It is difficult to accept this statement unreservedly, partly on account of the habit of assigning fabulous origins indulged by all archaic, and notably so by the Irish writers, but chiefly because the Brehon code comprises a very full law of *fences*. The materials, dimensions, and several sorts of quick-setting of these are laid down with great particularity, and the rights and liabilities of adjoining owners are minutely described. Returning to the subject of judicial administration, we have a much clearer view given of the nature and incidents of *process* by which the jurisdiction of the court was made to attach, than of the constitution of the court itself. This was by *distress*, or the seizure of the goods of the defendant, in some cases immediate, in others preceded by summons, and, in the case of the privileged classes, by *trosgad* or fasting on the part of the plaintiff, a practice still known in some parts of India, and much relied on as an evidence of common Aryan origin for the ancient Irish and present Hindu legal systems. The distress might either remain in the hands of the defendant, if of the superior grade, by way of attachment (*fornasc*), subject to a lien. on security for his appearing and abiding the award of the court, or it might at once be driven to a pound (*forus*). Here it was kept during a certain time or "stay" (*anad*), varying with the nature of the complaint, during which the defendant might have it back on like security. Failing this, a process of forfeiture (*lobad*) commenced, and ultimately the distress, or so much of it as sufficed to satisfy the claim, vested in the plaintiff, the defendant receiving back the balance, if any. On security being given, the merits of the dispute were determined by the court. A proceeding analogous to the action of *replevin* was thus incidental to every litigation; and this appears to have been the early course of the common law in all the local courts, not proceeding on the king's writs, both of England and Scotland, down to the times of Bracton (fo. 156. 2, Reeves's *Hist. Eng. Law*, 59), and of the enactment "*Quoniam attachiamenta*" (*Leges Bar. Scot.*, i. and cxi.). One of the few *cases* cited in the Brehon law (vol. i. p. 65) states the procedure in what was substantially an inter-tribal action of ejectment for recovery of land, in the incidents of which a resemblance is found to many principles of jurisprudence and methods of procedure of the common law of England, such as prescription, limitation, set-off, entry, ouster, distress, rescue, fresh pursuit, withernam, replevin, surety in replevin, avowry, Welsh mortgage, writ of possession, and return of distress. The case was this:—

Land had been assigned by way of Welsh mortgage in part payment of a mulct or fine. The mortgagee and his descendants remained in possession until it became a question whether the law of prescription (*rudrad*) had not given them the absolute estate. To try the title, a bailiff of the claimant tribe put his horses on the land. The bailiff of the tribe in possession drove them off, accompanying the act with an admission that formerly the claimant tribe had been in possession. The claimant's bailiff then distrained three cows of the occupier's bailiff outside his cattle shed, and drove them to the border of the territory, where they lay down. It would have been his duty here to give public notification of his proceedings, and to have driven his distress to the nearest pound of the external territory; but the cows, not having been milked, escaped, and returned to their calves, which had been left behind. The distrainer, making fresh pursuit by the traces of the milk dropped on the ground (regarded probably as a constructive keeping in view), recaptured them at daybreak at the homestead of the owner, and, with them, in addition, distrained and impounded three [six (]] others, taken from [out of] the door of the cattle-shed, by way of *aitherach gabail*, or second caption, to double the amount for what seems to have been considered a constructive rescue implied by the escaped beasts being again in the owner's custody. Notwithstanding these facts, the regularity of the proceeding was admitted by the tribe in possession, whose *regulus* now came forward and had back the distress, on giving pledges to try the question at law, and to return the cattle if unsuccessful. Further security was also given by him for some other liability. The action which, so far, was in the nature of replevin, now assumed the character of ejectment, and the personal wrong of ousting the bailiff who had made the entry merged in the question of title to the possession of the land. It was held that the period of prescription, being the time of three successions to the kingship, had not expired, one of the successions being irregular. The land was, therefore, still redeemable, and, on taking an account and setting off the receipts, including a mulct of less amount due by the mortgagee, against the original balance due to him, it was found he had been fully paid, and a return of the cattle was awarded, and possession of the lands delivered to the claimant. (See "On the Rudiments of the Common Law discoverable in the published portion of the *Senchus Mor*," in *Trans. Roy. Irish Academy*, vol. xxiv. p. 83, 1867.)

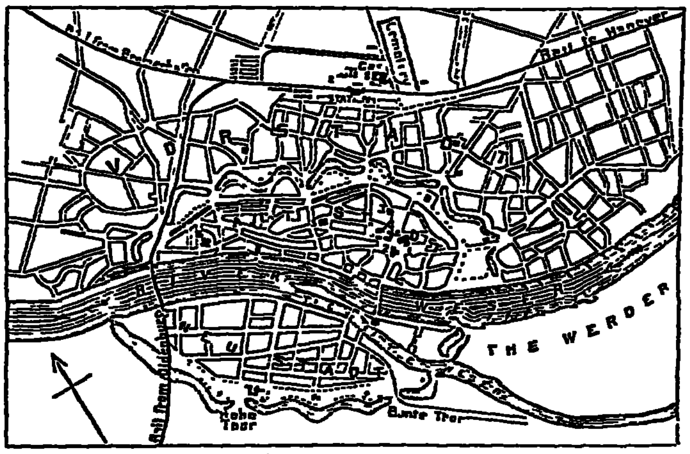
It appears from this that the provisions of the statute of Marlbridge (52 Henry III. c. 4) in England, forbidding the driving of distresses beyond the bounds of the county, and of the "Regiam Majestatem" (re-enacted by 1 Robert, i. c. 7) in Scotland, requiring that when driven beyond the bounds of the territory the distress shall be exhibited before witnesses, are to be regarded not as merely introductive enactments, but as substantially declaratory of the previous state of the common law; further, that the old opinion that "all administration of justice was at first in

the king's hands, but afterwards, as the kingdom was divided into counties, hundreds, &c., so the administration of justice was distributed among divers courts, of which the sheriff had the government of the county court, &c.," is probably grounded on an inversion of the actual progress of the facts; and that when it is said of the right to recover land in a personal action, of set-off, and of other equitable incidents of justice, that such rights did not exist at the common law, the words "in actions commenced by original writ," should probably be understood; for there is no difficulty in conceiving how all the main incidents and principles of law disclosed by the Irish case could have arisen regularly in the county court, always a court of equity for the defendant, when the bishop was associated with the sheriff, and the right of the suitor to be his own apparitor had not yet been abrogated by the law of Canute, re-enacted by William I. (*Leg. Gul. Conq.*, xliv.). How these resemblances have come to exist in the early laws of the two islands may be a question for the historian and ethnologist. It is well to know that, whencesoever derived, the common law may to so great an extent be recognized as substantially a common inheritance of all the populations now organized into the United Kingdom. (S. F.)

BREISLAK, SCIPIONE, an eminent geologist, was born at Rome in 1748. He early distinguished himself as professor of mathematical and mechanical philosophy in the college of Ragusa; but after residing there for several years he returned to his native city, where he soon became a professor in the Collegio Nazareno, and began to form the fine mineralogical cabinet in that institution. His leisure was dedicated to geological researches in the Papal States. His account of the aluminous district of Tolfa and adjacent hills, published in 1786, gained for him the notice of the king of Naples, who invited him to inspect the mines and similar works in that kingdom, and appointed him professor of mineralogy to the Royal Artillery. The vast works for the refining of sulphur in the volcanic district of Solfatara were erected under his direction. He afterwards made many journeys through the ancient Campania to illustrate its geology, and published in 1798 his *Topografia Fisica della Campania*, which contains the interesting results of much accurate observation. Breislak also published an essay on the physical condition of the seven hills of Rome, which he regarded as the remains of a local volcano,—an opinion which more recent investigations appear to disprove. The political convulsions of Italy in 1799 brought Breislak to Paris, where he remained until 1802, when, being appointed inspector of the saltpetre and powder manufactories near Milan he removed to that city. He died on the 18th of February 1826.

During the latter part of his career he published the following works:—*Del Salnitro e dell' Arte del Salnitraio*; *Memoria sulla Fabbricazione e Raffinazione dei' Nitri*; *Instruzione pratica per le piccole Fabbricazione di Nitro, da farsi dalle persone di Campagna.* His valuable *Introduzione alla Geologia* appeared in 1811; a French edition with additions was published in 1819. Finally, the Austrian Government, in 1822, took on itself the expense of publishing his *Descrizione Geologica della Provincia di Milano.*

BREMEN, one of the three free cities of the new German empire, is situated on the River Weser, about 50 miles from the sea and 60 S.W of Hamburg. The latitude of the observatory is 53° 4′ 36″ N., and the longitude 8° 48′ 54″ E. The city consists of three parts—the old town (*Alt Stadt*) and its suburban extensions (*Vorstadt*) on the right bank of the river, and the new town, dating from the Thirty Years' War, on the left. The river is crossed by three bridges, of which the last was built in 1874–5. The ramparts of the old town have long been converted into beautiful promenades and gardens, but both the old and the new town are still surrounded with moats. The area of the whole city is great in proportion to its population, the houses in general being built to contain only one family. The public buildings, situated chiefly in the old town, comprise the following:—the cathedral, erected in the 12th century, on the site of Charlemagne's wooden church, and famous for its *Bleikeller*, or lead-vault, in which bodies may be kept a long time without suffering decomposition; the church of St Ansgarius, built about 1243, with a spire 400 feet high; the *Rathhaus*, a building of the early part of the 15th century, with a celebrated underground wine-cellar; the town-house, formerly the archiepiscopal palace, and converted to its present uses only in 1819; the Schütting, or merchant's hall, originally built in 1619 for the guild of cloth-traders; the exchange, completed in 1867; the theatre; the town library; the high-school, a quite recent erection; and the new post-office buildings. St Rembert's church and the colosseum may be mentioned in



Plan of Bremen.

1. Cathedral. 2. Exchange. 3. Museum. 4. Rathhaus. 5. St Ansgarius. 6. St Stephan

the Vorstadt; and the barracks in the new town. At the head of the monetary establishments stands the *Bremer Bank*, which was founded in 1856 as a private speculation, and is only allowed to issue notes to the amount of its realized capital. Seven other banks were in operation in the beginning of 1875. There are in the city eighteen public and thirteen private schools, the former including a navigation and an industrial school, and the latter an institution for the extension of female labour.

New waterworks, constructed by an English company on the left side of the river, were opened in 1872, and supply the city with water of a good quality from the Weser; a large fire-brigade establishment has also been founded in imitation of a similar institution at Berlin; and an extensive park, the *Bürger Park*, has been laid out in the old Bürger Weide, or meadows. Railway communication is rapidly increasing, and a central terminus for all the lines is proposed. The most important of those already open connect the city directly with Hanover, with Oldenburg, with Bremerhaven, with Hamburg, and with Minden. The manufactures of Bremen are of considerable extent and variety, the most important being those of tobacco, snuff, and cigars, though they have somewhat declined since the formation of the empire. In 1872 no fewer than 2500 people were employed throughout the state in preparing cigars alone, while the making of cigar-boxes occupied 250 more. The shelling of rice is also largely carried on, and there are sugar-refineries, soap-works, shipbuilding-yards, sail-cloth factories, a large iron foundry, distilleries, asphalt-works, and colour-factories. In the extent of its foreign trade Bremen is one of the chief cities in Germany, and as a port of emigration it is only rivalled by Hamburg. It deals largely with the United States, Great Britain, British India, and Russia. Its principal imports consist of cotton, tobacco, coffee, rye, rice, coals, iron goods, petroleum, glass, hides and skins, silk, wool, linen, and dyes,

and its exports of many of these articles in a manufactured state. In 1874 the arrivals were 3407 vessels, with a register of 990,101 tons,—650 belonging to Bremen, 418 to Britain, and 317 to Holland. Much of the shipping trade of the city is conducted at Bremerhaven and Vegesack, because vessels drawing more than 7 feet cannot get up to the town. Among the societies of the city are a nautical association, the German Life-Boat Institution, and the chamber of commerce.

As early as 788 Bremen, then a mere fishing village, was made the seat of a bishopric by Charlemagne; and in 858 it was raised to an archbishopric by Ansgarius, archbishop of Hamburg, who had been driven from that city by the Normans about 847. The importance of Bremen soon increased; and its citizens took an active share in the more remarkable movements of the time, such as the Crusades, the establishment of the Teutonic Order, and the founding of Riga. In 1283 they joined the Hanseatic League, and in 1289 formed a treaty with Gisalbert, their archbishop, by which he agreed to confine himself to the spiritual affairs of his diocese, leaving secular concerns to the civic authorities. In the course of the 14th century, there was much intestine conflict in the city, and in the 15th it had to defend its commerce against the pertinacious hostility of the Frisian pirates; but from both perils it issued with increased vigour. About 1522 the archbishop and most of the inhabitants declared for Protestantism, in defence of which they took a foremost part, and had on various occasions to suffer severely. The city was twice besieged by the imperial forces in 1547. At the peace of Westphalia (1648) the archiepiscopal diocese was secularized and raised to a grand duchy, which was ceded to Sweden. In a war between Denmark and Sweden in 1712 it was conquered by the former, and in 1715 it was purchased from that power by Hanover along with the duchy of Verden. The transfer was confirmed by the diet of 1732, and the district now forms part of the Hanoverian province of Stade. The city of Bremen had meanwhile had its civic rights more or less thoroughly recognized during these vicissitudes. In 1806 it was taken by the French, and from 1810 to 1813 it was the capital of the department of the Mouths of the Weser. Restored to independence by the congress of Vienna in 1815, it subsequently became a member of the German confederation, and in 1867 joined the new confederation of the North German States, with which it was merged in the new German empire. It has now one vote in the federal council, and sends a representative to the imperial diet. The freedom of its port is secured, and in compensation it pays an *aversum* of 250,000 thalers to the customs union.

The territory of Bremen has an area of 63,400 English acres, about 5000 acres being occupied by the towns of Bremen, Bremerhaven, and Vegesack, and about 1200 by the bed of the Weser. Of the remaining area about two-fifths are arable land and two-fifths meadowland, the extent of woodland being very slight. The soil is for the most part sandy, though here and there marshes or bogs occur. Of the population, which in 1873 was 130,871, 88,146 were inhabitants of Bremen the city, 12,129 of Bremerhaven, and 3843 of Vegesack, and 26,753 of the rural districts. With the exception of about 2800 Roman Catholics and 271 Jews, the inhabitants are Lutherans or Calvinists of various denominations. According to the constitution of 1849, modified by various enactments in 1854, the senate, which is the executive power, is composed of eighteen members, elected by the "burghership" on presentation by the senate. Of these, ten at least must be lawyers, and five merchants; and two of the number are nominated by their colleagues as burgomasters, who preside in succession, and hold office for four years, one retiring every two years. The burghership consists of 150 (formerly 300) representatives chosen from the citizens for six years. Sixteen are elected by those of the inhabitants of the city who have attended a university, 48 by the merchants, 24 by the manufacturers and artisans, and 30 by the other citizens; of the remaining representatives 6 are furnished by Bremerhaven, 6 by Vegesack, and 20 by the country population. The revenue in 1873 amounted to £545,531, and the expenditure was £1,094,222, so that the deficit was £548,691. The total debt at the end of the year was £3,676,738. The territory and city are still outside the limits of the customs union. In the whole state there were in 1870 forty-five public and thirteen private schools, with a total attendance of 12,794.

BREMER, Fredrika, the most celebrated Swedish novelist, was born near Abo, in Finland, on the 17th August 1801. Her father, a descendant of an old German family, was a wealthy iron master and merchant. He left Finland when Fredrika was three years old, and after a year's residence in Stockholm, purchased an estate at Arsta, about 20 miles from the capital. There, with occasional visits to Stockholm and to a neighbouring estate, which belonged for a time to her father, Fredrika passed her time till 1820. The education to which she and her sisters were subjected was unusually strict; their parents, especially their father, were harsh and took little or no pains to understand the temperaments of the children. The constant repression, the sense of being misunderstood, and the apparent aimlessness of such an existence told with greatest force upon Fredrika, who was of a quick and eager disposition, fond of praise and conscious of powers which it seemed to her must lie for ever unused. She felt as if her life were being wasted; there was nothing on which she could expend her energy; no career was open to a woman. Her health began to give way; and in 1821 the whole family set out for the south of France. They travelled slowly by way of Germany and Switzerland, and returned by Paris and the Netherlands. It was shortly after this time that Miss Bremer became acquainted with Schiller's poetical works, which made a very deep impression on her. Her home life, however, was still unsatisfying, and in her passionate longing for some work to which she could devote herself, and through which she might do some good in the world, she for a time resolved to join one of the Stockholm hospitals as a nurse. This plan was given up on the entreaty of her sister. Meanwhile, she had found relief for her pent-up feelings in writing, or rather in continuing to write, for she had been an authoress of a sort from the age of eight. In 1828 she determined to attempt publication, and succeeded in finding a publisher. The first volume of her *Sketches of Every Day Life* (1828) at once attracted attention, and the second volume (1831), containing one of her best tales, *The H—— Family*, gave decisive evidence that a real novelist had been found in Sweden. The Swedish Academy awarded her their smaller gold medal, and the fortunate authoress became famous. From this time Miss Bremer had found her vocation. Her father had died in 1830, and her life was thereafter regulated in accordance with her own wishes and tastes. She lived for some years in Norway with a friend, after whose death she resolved to gratify a long-repressed desire for travel. In the autumn of 1849 she set out for America, and after spending nearly two years there returned through England. The admirable translations of her works by Mary Howitt, which had been received with even greater eagerness in America and England than in Sweden, secured for her a warm and kindly reception. Her impressions of America, *Homes in the New World*, were published in 1853, and were at once translated into English. After her return Miss Bremer devoted herself to her great scheme for the advancement or, one may say, emancipation of women. On this subject she had thought deeply, and her own experience was of value to her in shaping her ideas of what the education and function of woman should be. "She wished," says her sister, "that women should, like men and together with them, be allowed to study at the elementary schools and academies, in order to gain an opportunity of obtaining suitable employments and situations in the service of the state. . . . She said she was firmly convinced that women could acquire all kinds of knowledge just as well as men, that they ought to stand on the same level, and that they ought to prepare themselves in the public schools and universities to become lecturers, professors, judges, physicians, and functionaries in the service of the state" (*Life*, &c., pp. 81–2). Some of these views were expounded in her later novels, *Hertha* and *Father and Daughter*, which naturally were not so successful as her other works. Miss Bremer not only wrote of her plans, but endeavoured, so far as she could, to induce women to devote themselves to some kind of work. She organized a society of ladies in Stockholm for the purpose of visiting the prisons, and during the cholera raised a society the object of which

was the care of children left orphans by the epidemic. In 1856 she again travelled, and spent five years on the Continent and in Palestine. Her reminiscences of these countries have all been translated into English. On her return she settled at Arsta, where, with the exception of a visit to Germany, she spent the remaining years of her life. She died on the 31st December 1865. Miss Bremer has been called, and with justice, the Miss Austen of Sweden. Her novels have the purity, simplicity, and love of domestic life, which are characteristic of the English writer. She is, however, inferior to Miss Austen in construction of plot and in delineation of character. Some of her best works show slight traces of overstrained sentiment, and the situations are occasionally somewhat melo-dramatic. *The Neighbours* is the most popular and the best of her tales; it is an admirable picture of Swedish home life, showing at times the quiet humour which is more prominent in *The H—— Family*. All the works have been translated into German and English, and the greater number of them into French. In America they have circulated very widely, and have been extremely popular.

See *Life, Letters, and Posthumous Works of F. Bremer*, by her sister, translated by Milow, London, 1868.

BREMERHAVEN, a seaport town belonging to the free city of Bremen, on the right bank of the Weser at the mouth of the Geest, in 53° 32′ N. lat. and 8° 34′ E. long. It is built on a piece of ground surrendered to Bremen in 1827 by Hanover, and increased by treaty with Prussia in 1869. The port was opened in 1830, and there are now, besides an excellent harbour, four large wet docks, five dry docks, hydraulic cranes, and lines of railway running along the quays. The entrance is free from ice nearly all the year round, even when the other ports of the neighbouring coasts are closed, and vessels drawing 22 feet can enter safely. The town is rapidly extending and will soon be united with Geestemünde. Among its public buildings the most remarkable is the great hospitium for emigrants, erected in 1830, which can accommodate 2500 persons. The Hanoverian fort and batteries, which formerly protected the town, have been removed, and their place is supplied by similar works farther down. The population, which in 1850 was only 3500, amounted in 1871 to 10,596.

BRENNUS, the name given in history to two kings or chiefs of the Celtic Gauls, probably not an appellative, but a title, the Cymric "*brenhin*"=king. (Dr Pritchard thinks it more probably the equivalent of the Welsh proper name "*Bran*.") The first Brennus crossed the Apennines into Italy, at the head of 70,000 of the tribe of Gauls known as Senones, and ravaged Etruria, 391 B.C. Some envoys from Rome, sent to watch their movements, were said to have taken an active part in a skirmish before the walls of Clusium; and the Gauls, failing to obtain the surrender of these men, marched at once for Rome. A Roman army of about 40,000 men was hastily despatched to meet them, and took up a position on the banks of the little river Allia, within twelve miles of the city. Here Brennus attacked and defeated them with great slaughter; and if he had pressed on at once, Rome would have lain at his mercy; for the greater part of the beaten army had placed the Tiber between themselves and the conquerors. But the Gauls lingered on the field of battle, mutilating the dead, and drinking to excess. The Romans gained time to occupy and provision the Capitol, though they had not force sufficient to defend their walls; their women and children were sent off to Veii; and when on the third day the Gauls marched in and took possession, they found the city occupied only by those aged patricians who had held high office in the state. Too old to be of service in the little garrison, and too proud to fly, they had all solemnly devoted themselves to death, and sat each in the porch of his house, in full official robes, awaiting the invaders. For a while these withheld their hands from them, out of awe and reverence; but the ruder passions soon prevailed, and they were all slaughtered. The city was sacked and burnt; but the Capitol itself withstood a siege of more than six months, saved from surprise on one occasion only by the wakefulness of the sacred geese and the courage of Marcus Manlius. (See MANLIUS.) At last the Gauls consented to accept a ransom of a thousand pounds of gold. As it was being weighed out the Roman tribune complained of some unfairness. Brennus at once threw his heavy sword into the scale; and when asked the meaning of the act, replied that it meant "*Væ victis*"—"the weakest must go to the wall." The Gauls returned home with their plunder, leaving Rome in a condition from which she took long to recover. A later legend, most probably an invention, represents Camillus as having suddenly appeared with an avenging army at the moment when the gold was being weighed, and having defeated and cut to pieces Brennus and all his host (Livy, v. 49).

The second Celtic chief who bears the name of Brennus in history is said to have been one of the leaders of an inroad made by the Gauls from the east of the Adriatic into Thrace and Macedonia, 280 B.C., when they defeated and slew Ptolemy Ceraunus, then king of Macedonia. Whether Brennus took part in this first invasion or not is uncertain; but its success, and the rich spoils brought home, led him to urge his countrymen to a second expedition, when he marched with an army of 150,000 foot and 60,000 horse through Macedonia, defeating such forces as were brought against him, and passing thence into Thessaly, ravaging as he went, until he reached the historic pass of Thermopylæ. To this point the united forces of the Northern Greeks—Athenians, Phocians, Bœotians, and Ætolians—had fallen back; and here the Greeks a second time held their foreign invaders in check for many days, and a second time had their rear turned, owing to the treachery of some of the natives, by the same path which had been discovered to the Persians two hundred years before. Their land force, however, succeeded in getting on board the Athenian fleet, which was lying off the shore to co-operate with them. Brennus and his Gauls marched on to attack Delphi, of whose sacred treasures they had heard much. But the little force which the Delphians and their neighbours had collected—about 4000 men—favoured by the strength of their position, made a gallant and successful defence. With or without the help of Apollo, who is said to have come to the aid of his sanctuary, they rolled down rocks upon the close ranks of their enemies as they crowded into the defile, and showered missiles on them from their vantage ground. A thunderstorm, with hail and intense cold, increased their confusion, and when Brennus himself was wounded they took to flight, pursued by the Greeks all the way back to Thermopylæ. Brennus killed himself, "unable to endure the pain of his wounds," says Justin; more probably determined not to return home defeated. Few of the invading force eventually escaped.

BRENTANO, CLEMENS, German dramatist and novelist, was born at Frankfort-on-the-Maine in 1777. His sister Elizabeth was the well-known Bettina von Arnim, Goethe's correspondent. He studied at Jena, and afterwards resided in Heidelberg, Vienna, and Berlin, leading a somewhat restless and unsettled life. In 1818 his disgust with all mundane affairs reached such a height that he withdrew from ordinary life and lived in the strictest seclusion at Dülmen. This continued for six years; the latter part of his life he spent in Ratisbon, Frankfort, and Munich. He died at Aschaffenburg 28th July 1842. Brentano belongs to the romantic school of German poetry, and his works, like all others of that class, are marked by excess of

fantastic imagery and by abrupt, bizarre modes of expression. His first published writings consisted of satires and poetical dramas (*Satiren und Poetische Spiele*, 1800); of his later dramas the best are *Ponce de Léon*, 1804, and *Victoria*, 1817; of his poems the best is *Die Gründung Prags*, 1816. On the whole his finest work is the short tale, or novelette, *Geschichte vom braven Kaspar und dem schönen Annerl*, a very perfect little piece, which has been translated into English. Brentano also assisted Ludwig Achim von Arnim, his brother-in-law, in the collection of the tales and poems forming *Des Knaben Wunderhorn*, 1806–8. The collected works appeared at Frankfort in 1852.

BRENTFORD, a town of England, in the county of Middlesex, 8 miles west of London, on a loop line of the South-Western Railway, in 51° 28′ N. lat. and 0° 20′ W. long. It is divided by the River Brent into two parts, known as Old and New Brentford (the former the larger of the two), and is separated from Kew by the Thames. The Grand Junction Canal joins the Brent some miles further up, so that the town has extensive water communication, and is enabled to maintain a considerable trade. Among its manufacturing establishments are gin-distilleries, a brewery, malt-kilns, soap-works, saw-mills, and colour-works. The Grand Junction Water-works, which supply the west end of London, are stationed here, the great stand-pipe, 226 feet high, forming a striking tower-like structure. Market-gardening is largely carried on in the neighbourhood, and there is a weekly market which dates from the time of Edward I. The elections for the county of Middlesex are held in the town. Its population in 1871 was 11,091.

In 1016 Brentford, or, as it was often called, Braynford, was the scene of a great defeat inflicted on the Danes by Edmund Ironside. In 1280 a toll was granted by Edward I. for the construction of a bridge across the river, and in the reign of Henry VI. a hospital of the Nine Orders of Angels was founded near its Western side. In 1642 a battle was fought here between the royalists and the parliamentary forces, for his services in which the Scotsman Ruthven was made earl of Brentford, a title afterwards conferred on Marshal Schomberg. Brentford was during the 16th and 17th centuries a favourite resort of the London citizens; and its inn of the Three Pigeons, which was kept for a time by John Lowin, one of the first actors of Shakespeare's plays, has been frequently alluded to by the dramatists of the period. We have also Shakespeare's "Fat Woman of Brentford" in the *Merry Wives of Windsor*, "Gillian of Brentford" in *Westward Ho*, and various other references in old plays. Thomson, in his *Castle of Indolence*, refers to the pigs for which the town was formerly famous—

"E'en so through Brentford town, a town of mud,
An herd of bristly swine is pricked along."

The two kings of Brentford, so well known from Cowper's allusion, seem to owe their mythical existence to Buckingham's *Rehearsal*, where Bayes prides himself on the skill of his plot, in which he supposes "two kings to be of the same place, as for example at Brentford." See *Athenæum*, 1847, p. 1196; and *Notes and Queries*, 2d ser. vol. viii.

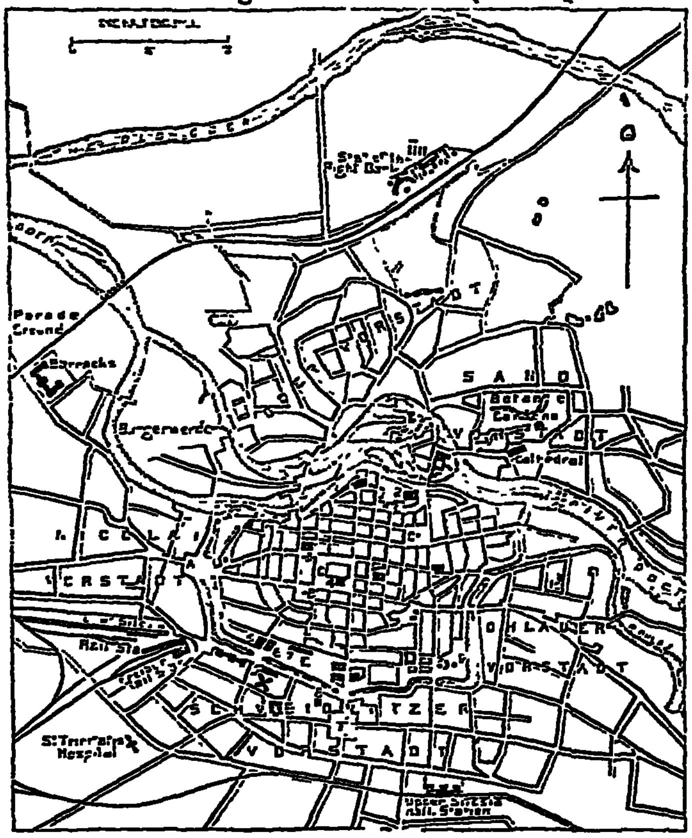
BRESCIA, or BRESCIANO, a province of Italy, in Lombardy, bounded on the N.W. by Bergamo, N.E. by Tyrol, E. by Verona, from which it is separated by the Lago di Garda, S.E. by Mantua, and S.W. by Cremona. Its area is rather more than 1643 square miles. The northern part, or about one-third, is occupied by a chain of mountains which belong to the Rhætian Alps; the remainder forms part of the great plain of Lombardy, and shares in its general fertility. The principal rivers, all tributaries or sub-tributaries of the Po, are the Oglio, the Mella, and the Chiese. Corn, flax, hemp, the olive, and the vine are extensively cultivated, and in some districts the traveller passes for miles through the midst of orchards. The mountainous parts, and especially the valley of Trompia, yield iron, copper, marble, alabaster, and granite. The manufactures consist principally of silk, woollen, linen, and cotton goods, iron, steel, and copper wares, glass, and paper. Among the principal townships are Rovato, Chiari, Orzinuovi, Monte-Chiaro, Salo, and Ponte-vico. Population in 1871, 456,023.

BRESCIA, the capital of the above province, is situated between the Mella and the Garza, about 155 miles by rail from Turin, in 45° 32′ N. lat. and 10° 14′ E. long. It lies at the foot of a spur of the Alps, on the summit of which is a fine old castle formerly known as the Falcon of Lombardy. The town is well built, has fine arcaded streets, and compares favourably in point of cleanliness with other cities in the North of Italy; but it has hardly so many buildings of first-class importance. The old cathedral, a remarkable specimen of the circular form, is sadly disfigured and neglected, and the new cathedral by its side (1604–1825), though built of white marble, is of little architectural merit, St Afra and San Francesco being more worthy of notice. The Broletto, or old palace of the republic, dating originally from the 12th or 13th century, is a large and interesting building; but it has suffered greatly by successive alterations. The episcopal palace contains an extensive public library, consisting principally of the books and manuscripts—many of great antiquity and value—bequeathed to the city by Cardinal Quirini in 1750. There is an exceptionally rich collection of both mediæval and classical antiquities, preserved in a beautiful Roman building, usually known as the Temple of Hercules, built by Vespasian and excavated in 1822; and throughout the numerous churches and mansions of the city are to be found many of the masterpieces of Italian art. Among the other buildings are the Loggia or communal palace erected in 1508, a theatre, a hospital, a lyceum, and various public fountains. The botanical gardens are worthy of notice. Brescia is a busy town. Its arms and cutlery have been famous for centuries; whole streets are occupied by coppersmiths; silk, woollen, and linen goods, paper, leather, and oil are manufactured; and an extensive transit-trade is carried on. The population in 1871 was 38,906.

Brescia, the ancient *Brixia*, is supposed to have been founded by the Etruscans. It was afterwards a town of the Cenomani, and, finally, a Roman free town. After the fall of the empire it was several times pillaged by the barbarians, especially by Attila in 452. From the Lombards, under whom it was the capital of a duchy, it passed to the Franks. It was made a free imperial city by Otho the Great, and shared and suffered in the contests between the Guelfs and Ghibellines. It then fell into the power of the Signiors of Verona, and in 1378 into the hands of the Milanese. It was taken in 1426 by Carmagnola the Venetian general; besieged by the Milanese general Picinino in 1483, but assigned to the Venetians by Pope Martin V.; surrendered by the inhabitants to the French after the battle of Agnano (1509); taken in 1512 by the Venetian general, Andrea Gritti; delivered by Gaston de Foix; and besieged again in 1573, 1575, and 1576. It remained under the Venetian dominion till the dissolution of the republic. It was the capital of the department of Mella during the existence of the Cisalpine republic and the Napoleonic kingdom of Italy, and fell in 1814 under the yoke of Austria. In the revolution of 1849 the inhabitants rose in arms, but were overpowered, after a destructive siege, by the troops of Haynau. In the war of 1859 it again sided with the patriotic party, and followed the destinies of the rest of Lombardy. Brescia has at various times suffered severely from pestilence and epidemics. It was the birthplace of Tartaglia the mathematician and the writer Mazzuchelli.

BRESLAU, a city of Prussia, capital of the government of Silesia, is situated mainly on the left but partly also on the right bank of the Oder, at the influx of the Ohlau, and on the railway from Berlin to Vienna, 190 miles S.E. of the former city. The latitude of the observatory is 51° 6′ 56″ N., and its longitude 17° 2′ 18″ E. The city consists of a new and an old town, and a number of extensive suburbs stretching out in all directions. The fortifications, which were dismantled shortly after 1813, have given place to beautiful promenades; and even in the older parts of the town, where the streets are generally narrow, there are

several open spaces of considerable area. The old cathedral (founded in the 12th century, and recently restored), the Catholic church of the Holy Cross, the Protestant church of St Elizabeth—with its lofty tower, the Jewish synagogue, and the bishop's palace are the principal ecclesiastical buildings. The *Rathhaus* (a fine specimen of



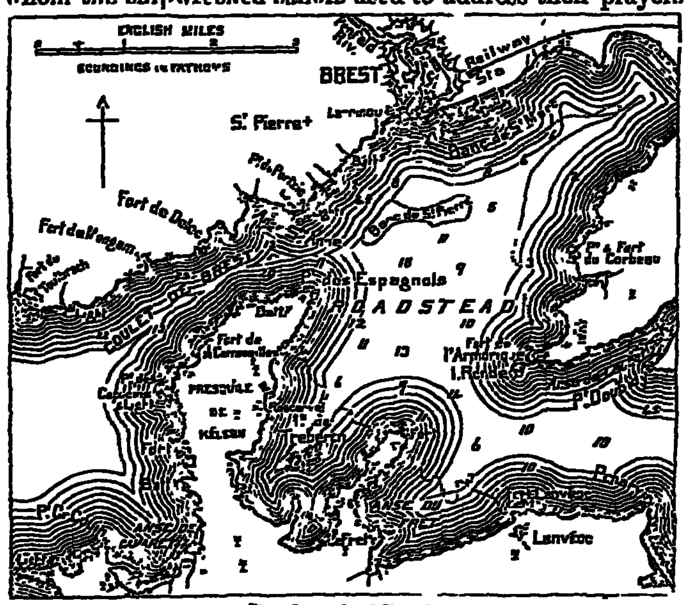
Plan of Breslau.

A, Königs Platz.
B, Blücher Platz and monument.
C, Ring Platz.
D, Ritter Platz.
E, Exercier Platz (Parade Ground)
F, Tauenzien Platz
G, New Market.
1. University.
2. Court-house.
3. S: Elizabeth's Church (Protestant).
4. Rathhaus.
5. Börse (Exchange)
6. Ständehaus.
7. Royal Palace.
8. Synagogue.
9. Liebliches Höhe.
10. Lobe Theatre.

the architecture of the 14th century), the townhouse (of quite recent erection), the royal palace (now used as the Government buildings), the chamber of the states, the exchange, the barracks, the theatre, the post-office, and the new court-house and prison are the more important of the secular structures At the head of the educational institutions for which Breslau is celebrated stands the university, which was founded in 1702 by Leopold I. as a Jesuit college, and was greatly extended by the incorporation of the university of Frankfort-on-Oder in 1811. Its library contains upwards of 300,000 volumes; and among its auxiliary establishments are botanic gardens, an observatory, an anatomical and an antiquarian museum. In 1873 its professors and teachers numbered 103, and its students 962, the majority in the Faculty of Arts. Among the minor institutions are four gymnasiums, a higher girls' school, a normal school, a school of arts and manufactures, several orphanages, a deaf and dumb institute, and a blind asylum. There are also seventeen hospitals and numerous charitable foundations. The town is the seat of several provincial courts, a chamber of mines, an independent Roman Catholic bishopric, and a Protestant consistory. Its manufactures, which are both varied and extensive, comprise machinery and tools, railway carriages, cast-iron goods, gold and silver work, carpets, woollen cloth, cotton goods, paper, and musical instruments. A very active export trade is carried on; and a number of large fairs for particular kinds of goods are held every year. The population, which was 110,702 in 1849, had increased to 171,926 in 1867, when about 33 per cent. was Roman Catholic, 58 Protestant, and 7 Jewish. In 1871 the total amounted to 207,977.

Breslau (Latin, *Vratislavia*) is first mentioned by Ditmar, the chronicler, in 1000 A.D.; and its foundation seems to be of slightly earlier date. It became the seat of a bishop in 1052, and the capital of an independent duchy in 1163. In 1241 it was reduced to ashes by the Mongolian invaders; but it soon recovered its prosperity, and, its population becoming largely Germanized, it joined the Hanseatic League in 1261. On the death of Henry, the last duke, in 1335, the lordship of Breslau passed to the Bohemian crown; and several of the Bohemian kings bestowed numerous privileges on the city, which began to extend its commerce in all directions,—to Russia and Tartary, Greece and Italy, the Netherlands and Flanders. Under the stimulus of prosperity the citizens soon showed themselves disposed to assert their independence, both against the aristocratic element within their walls, and against their feudal superiors without. From 1482 to 1490 they suffered severely from the oppressive measures of Stein, the minister of their king, Corvinus of Hungary, whom they had preferred to George Podiebrad of Bohemia. After the battle of Mohacz, Breslau passed with the rest of Silesia to the house of Austria, in whose possession it continued till 1741, when it was captured by Frederick II. of Prussia. In 1757 it was retaken by the Austrians under Charles of Lorraine, but in the same year the Prussians again made good their claim by force of arms, and took no fewer than 21,000 men prisoners. The attempt of Laudon in 1760 to surprise the city was a failure. It was forced, however, after a lengthened siege to yield to the French in 1806–7. Their subsequent investment of it in 1813 was interrupted by the peace.

BREST, a strongly fortified seaport town of France, capital of an arrondissement in the department of Finistère, in 48° 22′ N. lat. and 4° 32′ W. long. It is situated to the north of a magnificent land-locked bay, and occupies the slopes of two hills divided by the River Penfeld,—the part of the town on the left bank being regarded as Brest proper, while the part on the right is known as Recouvrance, from the chapel of the Virgin, to whom the shipwrecked sailors used to address their prayers



Roadstead of Brest.

for the recovery of their property. The hill-sides are in some places so steep that the ascent from the lower to the upper town has to be effected by flights of stairs; and the second or third story of one house is often on a level with the ground story of the next. The town proper has three long parallel streets, of which the chief bears the name of Rue de Siam, in honour of the Siamese embassy sent to Louis XIV., and terminates at the remarkable swing-bridge, or *Pont Impérial*, constructed in 1861, which crosses the mouth of the Penfeld. Running along the shore to the south of the town is the Cours d'Ajot, one of the finest promenades of its kind in France, named after the engineer who constructed it. It is planted with trees and

adorned with two marble statues presented by the "Gouvernement Consulaire, Le XIIII°. Germinal, An IX." Brest possesses comparatively few buildings of importance, with the exception of those connected with the great naval establishment. The church of the priory of the Seven Saints, the church of St Louis, the old castle with its seven massive towers (dating in part from the 13th century), the exchange, the town-house, the civil hospital, and the theatre are the chief. The great convict establishment, which formerly held some 3000 prisoners, was vacated in 1860, and is now used as a store-house. The Government dockyard is very extensive, and contains a sail-loft, a slop-shop, a ropery, a foundry and steam-factory, seamen's barracks (known as *La Cayenne*), and three dry-docks partly excavated in the hill-side. The Hôpital de la Marine, built between 1824 and 1835, contains 26 wards, each with 53 beds, and is under the management of a large band of sisters of mercy. Among the minor establishments are a lyceum, a school of navigation, a medico-chirurgical school, an observatory, a botanical garden, a public library of 25,000 volumes, and two others of 18,000 and 10,000. The manufactures are few, and the trade is of small extent considering the excellence of the ports. The former are chiefly leather, wax-cloth, paper, and rope; and the latter deals mainly in grain, beer, brandy, and fish. Napoleon III. did much for the development of the commerce of Brest, though his extensive plans for a new port, on which £600,000 were expended during his reign, have been only partially carried out. It lies at the foot of the Cours d'Ajot, and has thus much greater scope for any necessary development than the old port, which was formed by the mouth of the Penfeld. The roadstead of Brest, which is in some places three miles broad, and has an area of 15 square leagues, is formed by the promontory of Finistère on the N. and that of Kélernn on the S. It breaks up into numerous smaller bays or arms, formed by the embouchures of streams, the most important being the Anse de Kélernn, the Anse de Poulmie, and the mouths of the Châteaulin, the Dolas, the Lauberlach, and the Landerneau. It is defended on every side by batteries and forts, the first system of which was erected in 1680 under the personal superintendence of Vauban. The only entrance, the Goulet, is about a mile wide; but the Mingant or Mingam rock in the middle compels vessels to pass under the batteries of either the one side or the other. In 1851 the population of the town was 36,500; in 1871 it was 66,272.

Nothing definite is known of Brest till about 1040, when it was ceded by the Count of Léon to the first duke of Brittany. In 1372 duke John IV. gave it up to the English on condition that they should restore it when peace was proclaimed. So important did he consider the place that he declared, "He is not duke of Brittany who is not lord of Brest." On the death of Edward III. the castle was made over to the dukes; but when war was once more declared between France and England, an English garrison took possession again, and repelled every effort to dislodge it; nor was the place surrendered till 1397, and then only in consideration of a heavy ransom. In the next century it was again captured by the English, and retaken by the French; and by the marriage of Louis XII. with Anne of Brittany, it passed to the French crown. The advantages of the situation for a seaport town were first recognized by Richelieu, who, in 1631, constructed a harbour with wooden wharves, which soon became a station of the French navy. Colbert changed the wooden wharves for masonry, and otherwise improved the port, and Vauban's fortifications followed in 1680–88. In 1694 an English squadron, under Berkeley, was miserably defeated in attempting a landing; but in 1794, during the revolutionary war, the French fleet, under Villaret de Joyeuse, was as thoroughly beaten in the same place by the English admiral Howe.

BREST-LITOVSK (in Polish Brzesc, and in the chronicles Berestie and Berestoff), a town of Russia, in the government of Grodno, and 131 miles S. from the city of that name, in 52° 5′ N. lat. and 23° 39′ E. long., at the junction of the navigable river Mukhovetz with the Bug. It contains two or three Greek churches, a Roman Catholic church, a Jewish synagogue—which was regarded in the 16th century as the first in Europe, a monastery, a public hospital, a Jewish almshouse, an important provision storehouse, a custom-house, and a wharf. Brest is the seat of an Armenian bishop, who has authority over the Armenians throughout the whole country; and since 1841 the "Alexander" cadette-corps has been stationed in the town. The industries of the place are comparatively unimportant, but it carries on a very extensive and varied trade by means of its rivers and the Royal Canal. The principal articles of the traffic are grain, flax, hemp, wood, birch-tar, and leather. The population numbered 19,343 in 1860, 3394 being Catholics, and 10,320 Jews. In 1867 the total had risen to 22,493.

First mentioned in the beginning of the 11th century, Brest continued to pass from one principality to another till 1392, when it was incorporated with Poland. In 1241 it had been laid waste by Tatars, and was not restored till 1275; its suburbs were burned by the Teutonic knights in 1379, and in the end of the 15th century the whole town met a similar fate at the hands of Mengly-Gherai of the Crimea. In the reign of Sigismund diets were held in Brest; and in 1594 and 1596, it was the meeting-place of two remarkable councils of the bishops of Western Russia. In 1706 the town was captured by the Swedes; in 1793 it was added to the Russian empire; and in 1794 was the scene of Suwaroff's victory over the Polish general Sierakofsky.

BRETAGNE. See Brittany.

BRETSCHNEIDER, Karl Gottlieb, an eminent scholar and theologian, of the more moderate school of German rationalism, was born on the 11th February 1776, at Gersdorf in Saxony. From his autobiography, which was found amongst his papers after his death, and was published by his son in 1851, we obtain a very complete picture, not only of the man himself, but of the times in which he lived, and of the influences by which he was surrounded. His father was pastor of the village of Gersdorf, but was translated to Lichtenstein when Bretschneider was only four years of age. He gives an interesting account of his early childhood and school training, of the impression produced upon him by his father's dignified bearing, and of the agricultural pursuits and piscatorial amusements by which the clerical and pædeutic labours of the latter were diversified. On the death of his father, in 1789, he was sent to Hohenstein to reside with his uncle Tag. It is in keeping with the mental characteristics of the man who afterwards became famous for that cool and deliberate exercise of the reason on theological subjects, which has led many to place him among the extreme school of rationalist divines, to find him at the early age of fourteen, when he was confirmed by the pastor of Hohenstein, criticizing the religious teaching of his instructor, and pointing out that the order in which the various doctrines were taught from the Dresden catechism was not such as could commend itself to his own experience, or the course of moral education which he had undergone. He remarks that he deems the circumstance worthy of mention, "because it was the first time that, having turned his thoughts to the subject of religion, he could not persuade himself of the truth of what he was taught, and that a similar process may be going on in the minds of many a youth in similar circumstances, without the instructor being at all aware of it."

In 1790 Bretschneider was sent to the lyceum of Chemnitz, where the celebrated Heyne had received his classical education. Here he remained four years. The account which he gives of the state of education in this school (which had greatly fallen away from its former reputation), and of the capacity of his instructors, is interesting, and is strikingly illustrative of the growth of that critical faculty which became so prominent a feature

in his character. It was while at Chemnitz that Bretschneider became acquainted with the *Wolfenbüttel Fragments*. The conrector Lessing, a brother of the great Lessing, who was the editor of the *Fragments*, and who was believed for some time to be their real author, was inconsiderate enough to warn his pupils against reading any of his brother's works. The natural result followed. The prohibited books were eagerly sought after, and perused with avidity. Contrary, however, to what might at first have been expected, the persual of the *Fragments* made no impression on the mind of Bretschneider. The independent judgment of the youth is seen in the criticism which he passed upon the book :—"I read the portion," he says, "which treats of the miracles of the Old Testament. But the reading made no impression upon me, for Christianity did not appear to me to rest at all upon the miracles of the Old Testament."

In 1794 Bretschneider entered the university of Leipsic, having resolved to devote himself to the study of theology. His resolution to adopt this profession was purely the result of circumstances. "His father had expressed a wish that he should do so, and all his mother's brothers were clergymen." The lectures which he attended were those of Platner on philosophy, of Keil and Beck and Burscher on various branches of theology, and of Meisner and Kuhnoel on Hebrew. His autobiography contains minute and severe criticisms upon the various professors, in which the defects and mistakes of their teaching are pointed out. One or two of these may be quoted as indicative of the mental tendencies of the writer. Speaking of the lectures on philosophy, and after pointing out the defects of Platner's method, he says,—"Even at this early period, I learned from experience the impossibility for me of adopting any doctrine, except on condition of its standing fully and clearly developed before me,—a peculiarity which has adhered to me during my whole life, and has always preserved me from mysticism and the theology of feeling." Again, in referring to the lectures of Beck on the exegesis of Scripture, the future lexicographer of the New Testament appears in the remark,—"I well remember how burdensome the word πνεῦμα and πνεῦμα ἅγιον became, which he explained now as expressing *sensum christianum*, and now as *fervorem animi*, and then, again, as something else. I felt that these explanations were not correct, and consequently could not accept them." With the lectures of Keil, the successor of the celebrated Morus, Bretschneider appears to have been better satisfied. He adopted his principle of the historical interpretation of Scripture, and entered, as he says, "with the greatest zeal upon the study of the Jewish theology and its *usus loquendi*. In consequence of this, a multitude of arbitrary explanations were set aside, and neither for Teller's dictionary, nor for other modern interpretations, in which new ideas are attached to the words of Scripture, could I acquire the least relish. The efforts to explain away the devil from the Bible, to reduce the passages respecting Christ's pre-existence and higher nature to a moral sense, to make the miracles of the New Testament by exegetical subtleties mere natural events, were odious to me as denials of divine truth."

After spending four years at Leipsic, Bretschneider accepted the office of tutor to the sons of a Saxon nobleman, a post which he retained for some years. During this period his resolution to make the church his profession seems to have been somewhat shaken. His difficulties, however, were removed by reading the observations on assent to creeds in Reinhard's *Christian Ethics*, and also "by the thought that many great and estimable theologians varied widely from the church faith, and that in general society, and in the learned world, the *enlightened* theologians (for the term rationalist was not common then) stood in the highest repute, and were regarded with universal respect. This state of things I supposed would be permanent, and I could not then have believed that only a single generation would pass before the enlightened theologians would be assailed with such violence and bespattered with filth as they now are. Had I been able to foresee this, I should certainly have devoted myself to the study of law."

In 1802 Bretschneider passed with great distinction the examination for *candidatus theologiæ*, and on that occasion attracted the favourable regard of Reinhard, the celebrated court-preacher at Dresden, who became his warm friend and patron during the remainder of his life. In 1804 Bretschneider established himself as *privat-docent* at the university of Wittenberg, where he remained about two years, giving lectures on philosophy and theology. It was during this time that he began his career as an author. The first production of his pen was his *Dogmatische Entwicklung aller in der Dogmatik vorkommenden Begriffe nach den Symbolischen Schriften der evangelisch-lutherischen und reformirten Kirche und den wichtigsten dogmatischen Lehrbüchern ihrer Theologen, nebst der Literatur vorzüglich der neueren über alle Theile der Dogmatik*, which appeared in 1805, and reached a fourth edition in 1841, and which is distinguished for the complete account which it contains of the literature of the subject. This was followed by other works, among which may be named an edition of the book of Ecclesiasticus with a commentary in Latin, which was intended to form part of a larger work upon the Apocryphal books of the Old Testament,—an undertaking that was never carried out. The advance of the French army under Napoleon into Prussia after the battle of Austerlitz determined Bretschneider to leave Wittenberg, which as a fortified town was liable to be exposed to all the horrors of a siege. He accordingly abandoned his university career, and, through the good offices of his friend Reinhard, obtained the pastorate of Schneeberg in Saxony, on the duties of which he entered in March 1807. In 1808 he was promoted to the office of superintendent of the church of Annaberg, which, in addition to the properly clerical duties which belonged to the charge, involved the consideration of many matters belonging to the department of ecclesiastical law, which had to be decided in accordance with the canon law of Saxony. Bretschneider, however, devoted himself energetically to his duties. "The *Corpus Juris Saxonici*," he says, "was almost always on my table, and I soon became perfectly acquainted with its contents." In Annaberg he passed eight years, during which time he twice declined the offer of a professorship of theology, once from Königsberg and once from Berlin. The climate, however, did not agree with him, and in consequence of the demands made upon him by the discharge of his official duties, he was prevented from devoting sufficient time to his theological studies. He, therefore, began to desire a change. With a view to this, he publicly took the degree of doctor of theology in Wittenberg in August 1812. The subject of his thesis was "Capita Theologiæ Judaicæ," as gathered chiefly from the writings of Josephus. It was the last public doctorate of the kind, and cost him 300 thalers (£45), "an expense," he remarks, "which he often regretted, as the title was shortly after made common." It may have been some little consolation to him that the people of Annaberg on his return commemorated his promotion in a number of poems composed for the occasion.

The desired change came at last. In 1816, on the death of Loeffler, general superintendent at Gotha, he was appointed, on the recommendation of Von Ammon, Reinhard's successor at Dresden, to the vacant post, in which he remained until his death in 1848. This was the

great period of his literary activity. By a careful economy of time, he was able to discharge his official duties, and yet to possess sufficient leisure for theological study. Of the various productions of his pen, which appeared during his residence at Gotha, the following are specially worthy of note. In 1820 was published his treatise on the gospel of St John, entitled *Probabilia de Evangelii et Epistolarum Joannis Apostoli indole et origine eruditorum judiciis modeste subjecit K. G. Bretschneider*. The sensation which this work produced was immense. In it he collected together with great fulness, and discussed with marked moderation of tone, the various arguments which seem to prove the non-Johannine authorship of the gospel. As might have been expected, it called forth a host of replies, several of which proceeded from some of the ablest scholars and divines of the day. To the astonishment of every one, Bretschneider announced in the preface to the second edition of his *Dogmatik* in 1822, that he had never believed in the non-authenticity of the gospel, that he had only published his *Probabilia* to draw attention to the subject, and to call forth a more complete defence of its genuineness; an object which he considered had now been fully accomplished. Whatever may have been the effect produced on the mind of Bretschneider himself by the various replies which appeared, they certainly did not remove the doubts of others, for the controversy still appears as far from being definitely settled as it was when the *Probabilia* appeared more than half a century ago. Bretschneider remarks in his autobiography that the publication of this work had the effect of preventing his appointment as successor to Tittmann in Dresden, the minister Von Einsiedel violently opposing the proposal of the city council to call Bretschneider to the office, and denouncing him as the "slanderer of John" (*Der Johannis Schänder*).

The work by which Bretschneider conferred the greatest service upon the science of exegesis was his *Lexicon Manuale Græco-Latinum in libros Novi Testamenti*, which appeared in 1824, and which attained a third edition in 1840. This work is valuable for the use which its author made of the Greek of the Septuagint, of the Old and New Testament Apocrypha, of Josephus, and of the apostolic fathers in illustration of the language of the New Testament.

Bretschneider's dogmatic writings were very numerous, and many of them passed through several editions. The only one which has been translated into English is his *Manual of the Religion and History of the Christian Church*, which appeared in 1857.

The dogmatic position of Bretschneider seems to be intermediate between the extreme school of naturalists, such as Paulus, Röhr, and Wegscheider on the one hand, and that of Strauss and Baur on the other. Recognizing a supernatural element in Scripture, he nevertheless allowed to the full the critical exercise of reason in the interpretation of its dogmas. As a theologian he was deficient in speculative power, and his writings are marked by a certain dryness. His mental strength lay in the possession of a clear, cool judgment, which he never allowed to be influenced by feeling, and in the faculty of untiring industry.

For further information the reader is referred to his autobiography, *Aus Meinen Leben: Selbstbiographie von Karl Gottlieb Bretschneider*, Gotha, 1851, of which a translation, with notes, by Professor George E. Day, appeared in the *Bibliotheca Sacra and American Biblical Repository*, Nos. 36 and 38, 1852, 1853. (F. C.)

BREUGHEL, JAN, a Flemish painter, son of Peeter Breughel, was born at Brussels about the year 1569. He first applied himself to painting flowers and fruits, and afterwards acquired considerable reputation by his landscapes and sea-pieces. After residing long at Cologne he travelled into Italy, where his landscapes, adorned with small figures, were greatly admired. He left a large number of pictures, chiefly landscapes, which are executed with great skill. Rubens made use of Breughel's hand in the landscape part of several of his small pictures,—such as his Vertumnus and Pomona, the Satyr viewing the Sleeping Nymph, and the Terrestrial Paradise, which by some is regarded as the masterpiece of that great artist. Breughel died in 1642.

BREUGHEL, PEETER, a Flemish painter, was the son of a peasant residing in the village of Breughel near Breda. After receiving instruction in painting from Koek, whose daughter he married, he spent some time in France and Italy, and then went to Antwerp, where he was elected into the Academy in 1551. He finally settled at Brussels and died there. The subjects of his pictures are chiefly humorous figures, like those of D. Teniers; and if he wants the delicate touch and silvery clearness of that master, he has abundant spirit and comic power. He is said to have died about the year 1570 at the age of 60; other accounts give 1590 as the date of his death. Several other painters of the name Breughel attained to some distinction.

BREVIARIUM ALARICANUM, a collection of Roman law, compiled by order of Alaric II., king of the Visigoths, with the advice of his bishops and nobles, in the twenty-second year of his reign (506 A.D.) It comprises sixteen books of the Theodosian code; the Novells of Theodosius II., Valentinianus III., Marcianus, Majorianus, and Severus; the Institutes of Gaius; five books of the *Sententiæ Receptæ* of Julius Paulus; thirteen titles of the Gregorian code; two titles of the Hermogenian code; and a fragment of the first book of the *Responsa Papiani*. It is termed a code (codex) in the certificate of Anianus, the king's referendary, but unlike the code of Justinian, from which the writings of jurists were excluded, it comprises both imperial constitutions (*leges*) and juridical treatises (*jura*). From the circumstance that the Breviarium has prefixed to it a royal rescript (*commonitorium*) directing that copies of it, certified under the hand of Anianus, should be received exclusively as law throughout the kingdom of the Visigoths, the compilation of the code has been attributed to Anianus by many writers, and it is frequently designated the Breviary of Anianus (Breviarium Aniani). The code, however, appears to have been known amongst the Visigoths by the title of "Lex Romana," or "Lex Theodosii," and it was not until the 16th century that the title of "Breviarium" was introduced to distinguish it from a recast of the code, which was introduced into Northern Italy in the 9th century for the use of the Romans in Lombardy. This recast of the Visigothic code has been preserved in a MS. known as the Codex Utinensis, which was formerly kept in the archives of the cathedral of Udine, but is now lost; and it was published in the last century for the first time by Canciani in his collection of ancient laws entitled *Barbarorum Leges Antiquæ*. It has been published in the present century by Walter in his *Corpus Juris Germanici*, Berolini, 1824. Another MS. of this Lombard recast of the Visigothic code has lately been discovered by Hanel in the library of St Gall. Neither of these MSS. comprises the whole of the Visigothic code, and it is the opinion of very competent scholars that the Lex Romana of the Lombards did not contain any portion of the Gregorian or Hemogenian code nor the fragment of the *Responsa Papiani*. The chief value of the Visigothic code consists in the fact, that it is the only collection of Roman Law in which the five first books of the Theodosian code and five books of the *Sententiæ Receptæ* of Julius Paulus have been preserved, and until the discovery of a MS. in the chapter library in Verona, which contained the greater part of the Institutes of Gaius, it was the only work in which any portion of the institutional writings of that great jurist

had come down to us. The most complete edition of the Breviarium will be found in the collection of Roman law published under the title of *Jus Civile Ante-Justinianum*, Berolini, 1815.

BREVIARY (Lat. *breviarium*), the book which contains the offices for the canonical hours. The word first occurs in the 11th century, and is said to denote that the book was an abridgment of several separate ones which had previously been in use. The English equivalent for it is *portuary* (from the mediæval Latin *portiforium*), *portesse*, or *portuasse*, the name probably indicating the *portability* of the volumes.

In the earliest times most of the stated public devotions of the faithful grouped themselves round the daily celebration of the eucharistic sacrifice; but by degrees other offices were added, in which the recitation of the Psalter formed the principal part. The rise of monasticism gave a great impulse to the movement, as the monks generally used the whole Psalter every week, and many of them every day. Numerous complications were added by degrees, in the shape of antiphons, responses, &c. Metrical hymns seem to date from St Ambrose in the middle of the 14th century. Select portions of holy Scripture were also read, as well as extracts from works of the Fathers and from lives of the saints.

The canonical hours are eight in number; the night office of matins (divided into three nocturns) and seven day offices,—lauds, prime (at 7 A.M.), terce (at the third hour or 9 A.M.), sext (at the sixth hour, noon), nones (at the ninth hour, 3 P.M.), vespers (at sunset), and compline before retiring to rest.

From this account it will at once be seen that the Breviary services can only be carried out in a monastic community where all other duties give place to worship. Accordingly, the secular clergy of the Latin churches who are obliged to recite them daily are allowed much latitude in the way of grouping services together, and saying them at any hour that may be convenient, which quite destroys the grand theory of the nightly and seven-fold daily offices of devotion. There were three leading types of this service book in the Western churches:—(1), the Mozarabic Breviary, once in use throughout all Spain, but now confined to a single foundation at Toledo; it is remarkable for the number and length of its hymns, and for the majority of its collects being addressed to God the Son; (2), the Ambrosian, now confined to Milan, where it owes its retention to the attachment of the clergy and people to their traditionary rites which they derive from St Ambrose; and (3), the Roman, which (with many minor variations) forms the ground-work of all others except those just mentioned.

Till the Council of Trent every bishop had full power to regulate the Breviary of his own diocese; and this was acted upon almost everywhere. Each monastic community, also, had one of its own. Pope Pius V., however, while sanctioning those which could show at least 200 years of existence, made the Roman obligatory in all other places. But the influence of the court of Rome has gradually gone much beyond this, and has superseded almost all the local "uses." The Roman has thus become nearly universal, with the allowance only of additional offices for saints specially venerated in each particular diocese.

The Roman Breviary has undergone several revisions. The most remarkable of these is that by Cardinal Quignon (1536), which, though not accepted by Rome, formed the model for the still more thorough reform made in 1549 by the Church of England, whose daily morning and evening services are but a condensation and simplification of the Breviary offices. Some parts of the prefaces at the beginning of the English Prayer-Book are free translations of those of Quignon. At the beginning of last century a movement of revision took place in France, and succeeded in modifying about half the Breviaries of that country. Historically, this proceeded from the labours of Launoius and Tillemont, who had shown the falsity of numerous lives of the saints; while theologically, it was produced by the Port Royal school, which led men to dwell more on communion with God as contrasted with the invocation of the saints. This was mainly carried out by the adoption of a rule that all antiphons and responses should be in the exact words of Scripture, which, of course, cut out the whole class of appeals to created beings. The services were at the same time simplified and shortened, and the use of the whole Psalter every week (which had become a mere theory in the Roman Breviary, owing to its frequent supersession by saints' day services) was made a reality. These reformed French Breviaries show a deep knowledge of holy Scripture, and much careful adaptation of different texts; but during the pontificate of the present Pope (Pius IX.) a strong Ultramontane movement has arisen against them. It was inaugurated by the Count de Montalembert, but its literary advocates were chiefly the Abbé Gueranger and M. Veuillot of the *Univers;* and it has succeeded in suppressing them everywhere except at Lyons, where the shadow of St Irenæus still protects the local rites.

The beauty and value of many of the Latin Breviaries were brought to the notice of English churchmen by one of the numbers of the Oxford *Tracts for the Times*, since which time they have been much more studied, both for their own sake and for the light they throw upon the English Prayer-Book.

In a bibliographical point of view some of the early printed Breviaries are among the rarest of literary curiosities, being merely local. The copies were not spread far, and were soon worn out by the daily use made of them. Doubtless many editions have perished without leaving a trace of their existence, while others are known by unique copies. In Scotland the only one which has survived the convulsions of the 16th century is that of Aberdeen, revised by Bishop W. Elphinstone, and printed at Edinburgh by Walter Chepman in 1509. Four copies have been preserved of it, of which one only is complete; but it has been sumptuously reprinted in fac-simile for the Maitland Club by the munificence of the Duke of Buccleuch. It is particularly valuable for the notices of the early history of Scotland which are embedded in the lives of the national saints, and which are considered to be very authentic. For the sake of those who are not familiar with Latin typographical contractions, it would be desirable if a more readable edition were printed, with explanatory notes on the many difficult points which occur in the rubrics.

The Sarum or Salisbury Breviary was much more widely used. The first edition was printed at Venice in 1483, by Raynald de Novimagio in folio; the latest at Paris, 1556, 1557. It may be noticed as a peculiarity that, while modern Breviaries are always printed in four volumes, one for each season of the year, the editions of the Sarum never exceeded two parts.

Further information on this subject will be found in the writers on the services of the Western churches, such as Maskell and Procter. Seager has printed a small portion of the Sarum Breviary with elaborate notes. The hymns have been printed separately, with more or less completeness, by Daniel, Newman, and others; and translations from them form the ground-work of *Hymns Ancient and Modern*, now so extensively used in the Church of England. Foreign writers on this subject may be consulted by those who wish to pursue it further, but they are too numerous to be mentioned here. They will be found enumerated in bibliographical writers like Taccaria. (G. H. F.)

BREWING

BREWING is the art of preparing an exhilarating or intoxicating beverage by means of a process of fermentation. In the modern acceptation of the word, brewing is the operation of preparing beer and ales from any farinaceous grain (chiefly from barley), which is first malted and ground, and its fermentable substance extracted by warm water. This infusion is evaporated by boiling, hops having been added to preserve it. The liquor is then fermented.

The art was known and practised by the Egyptians many hundred years before the Christian era, and afterwards by the Greeks, Romans, and ancient Gauls, from whom it has been handed down to us. All countries, whether civilized or savage, have, in every age, prepared an intoxicating drink of some kind. In the second book of Herodotus, written about 450 B.C., we are told that the Egyptians, being without vines, made wine from corn; but as the grape is mentioned so frequently in Scripture and elsewhere as being most abundant there, and no record exists as to the vine having been destroyed, we must conclude that the historian was only partially acquainted with the productions of that most fertile country. Pliny (*Natural History*, xxii. 82) informs us that the Egyptians made wine from corn, and gives it the name of *zythum* which in the Greek would mean drink from barley; and Hellanicus, telling of the introduction of wine at Plinthium, a city of Egypt, states: "Hence the Egyptians are thought to derive their love and use of this liquor, which they thought so necessary for human bodies, that they invented a wine made from barley." The Greeks, who derived the greater part of their civilization from the Egyptians, obtained from them also the knowledge of artificial fermentation, the art of brewing in fact, and at a very early period. We find it mentioned, for example, in the writings of Archilochus, the Parian poet and satirist, who flourished about 700 B.C., that the Greeks of his day were already acquainted with the art.

Again, we learn from Æschylus (470 B.C.), from Sophocles (420 B.C.), and Theophrastus (300 B.C.), that the Greeks employed barley wine or beer (their *zythos*) in their daily life as well as in their festive meetings. There is, in fact, little doubt that the discovery of beer and its use as an exhilarating drink were nearly as early as those of the grape itself. Xenophon, in his account of the retreat of the ten thousand Greeks, written 400 years B.C., mentions that the inhabitants of Armenia used a fermented drink made from barley. Diodorus Siculus states that the Galatians prepared a fermented beverage from barley, calling it *zythos*, like the Egyptians. By Sophocles and other Greek writers it is styled βρῦτον. Dioscorides mentions two kinds of beer, one he calls ζῦθος and the other κοῦρμι, but he does not describe them sufficiently to enable us to distinguish them. Both, he says, were made from barley, and similar liquors were made in Spain and Britain from wheat. In the time of Tacitus (whose treatise on the manners and customs of the Germans was written in the 1st century of the Christian era), beer was their usual beverage, and from his description, imperfect as it is, there can be no doubt that they understood the method of converting barley into malt. Pliny mentions its use in Spain (*Nat. Hist.*, xxii. 82) under the name of *celia* and *ceria*, and in Gaul under that of *cerevisia* or *cervisia;* and elsewhere (xiv. 29) he says—"The natives who inhabit the west of Europe have a liquor with which they intoxicate themselves, made from corn and water. The manner of making this liquid is somewhat different in Gaul, Spain, and other countries; and it is called by different names, but its nature and properties are everywhere the same. The people of Spain in particular brew this liquor so well that it will keep good a long time. So exquisite is the cunning of mankind in gratifying their vicious appetites, that they have thus invented a method to make water itself produce intoxication."

The *cervisia* of Pliny evidently takes its name from Ceres, the goddess of corn. Plautus calls it *Cerealis liquor*, that is, liquor used at the solemn festival of that goddess. The art of malting and use of beer are supposed to have been introduced into Britain by the Romans. That barley was known to the latter is evident from Virgil, who uses it in the plural form, *hordea*, as we do the word oats; and Pliny tells of the *hordearii gladiatores*, a kind of fencers, whose sustenance was barley. Beer and vinegar were the ordinary beverages of the soldiers under Julius Cæsar. The latter was made very strong, and was drunk diluted with water when on the march. Beer being so suitable to the climate, and so easily made by an agricultural people with plenty of corn, it was gladly welcomed, and soon became the national beverage. Previous to this, the usual drinks of the ancient Britons were water, milk, and mead (an intoxicating drink made from honey). After the expulsion of the Romans from Britain, the Saxons subdued the natives and learned from them the art of brewing.

Dr H. J. Mann tells us that the Kaffre races of South Africa have made for ages, and still make, a fermented drink of beer from the seed of the millet (*Sorghum vulgare*), which is first subjected to a malting process in all essential particulars identical with our own. The seed is first induced to germinate by covering it in a warm place with moistened mats of grass, and the sprouting is then stopped by the application of heat. After simmering for some time in hot water, the malted grain is set aside to ferment in the sun—fragments of a dried succulent plant having been stirred in to play the part of yeast and start the fermentation. The scum which rises to the surface during the fermentation is skimmed away from time to time by ladles made of grass stems spread out and loosely woven together at the bowl. When the fermentation is complete the beer is poured through a mat strainer, shaped and tasselled very much like an inverted night-cap, into the store vessel, which is made of thickly and firmly woven grass. The natives of Nubia, Abyssinia, and other parts of Africa also make an intoxicating drink of great power called bousa, from the flour of the teff (*Poa abyssinica*), and from the durrha or millet (*Sorghum vulgare*), much esteemed by the natives, and perferred by many to palm or date wine, the common intoxicating drink in tropical countries. According to Mungo Park, the natives of Africa also make a beverage from the seed of the spiked or eared soft-grass (*Holcus spicatus*). The Russian drink kvass or quass, a thick, sour beverage, not unlike bousa, is made of barley and rye flour, mixed with water and fermented. Formerly, the spruce-fir, birch, maple, and ash trees were tapped, and their juice used in England,—the first two, indeed, till within the last fifty years. Koumiss, the drink of the Tatar race, is the fermented milk of their mares. The Chinese beverage, sam-shee, is made from rice. This is not only intoxicating, but, like absinthe, peculiarly mischievous in its permanent effects. In South America a favourite drink is pulque, the fermented juice of the American aloe (*Agave americana*). Guarapo is the juice of the sugar-cane, which, when fermented, forms the common drink of the negro

races, who also prepare a drink from rice and honey. Where beer has once been introduced, however, it has generally become the national beverage, and is now in universal use in the northern and temperate parts of Europe and Asia.

Beer used formerly to be made in England from wheat; but this beverage was not so well flavoured as if prepared from barley-malt, nor did it keep long. It was esteemed in Germany and Denmark, and was called by the Germans *Mumme*, and by the Danes *mom*. The German *Weiss-bier* is made from wheat-malt, with a small portion of barley-malt added.

We are informed by William of Malmesbury that, in the reign of Henry II., the English were greatly addicted to drinking. The monasteries were remarkable for the strength and purity of their ales, brewed from malt prepared by the monks with great care and skill. The waters of Burton-on-Trent began to be famous in the 13th century. The secret of their being so especially adapted for brewing was first discovered by some monks, who held land in the adjacent neighbourhood of Wetmore. There is a document still extant, dated 1295, in which it is stated that Matilda, daughter of Nicholas de Shoben, had re-leased to the abbot and convent of Burton-on-Trent certain tenements within and without the town; for which re-lease they granted her, daily for life, two white loaves from the monastery, two gallons of conventual beer, and one penny, besides seven gallons of beer for the men. The abbots of Burton must also have made their own malt, for it was a common covenant in leases of mills belonging to the abbey, that the malt of the lords of the manor, both spiritual and temporal, should be ground free of charge. Mary Queen of Scots, in the midst of her troubles, seems not to have been altogether insensible to the attractions of English beer, for when she was confined in Tutbury Castle, Walsingham her secretary asked, "At what place near Tutbury beer may be provided for her majestie's use?" to which Sir Ralph Sadler, governor of the castle, made reply, "Beer may be had at Burton, three miles off." Plot, in his *Natural History of Staffordshire*, written 200 years ago, refers to the peculiar properties possessed by the Burton waters, from which, he says, "by an art well known in this country good ale is made, in the management of which they have a knack of fining it in three days to that degree that it shall not only be potable, but is clear and palatable as one could desire any drink of this kind to be." In 1630 Burton beer began to be known in London, being sold at "ye Peacocke," in Gray's Inn Lane, and, according to the *Spectator*, was in great demand amongst the visitors at Vauxhall. In 1585 Stow relates that there were 26 brewers in the city of London, the suburbs, and Westminster,—13 being English and 13 foreigners,—who brewed 648,960 barrels of beer, of which they exported 26,400 barrels to Embden, the Low Countries, and Dieppe. In 1643 the first excise was imposed on beer. In William III.'s reign, the brewer sold his nut-brown ale at 16s. per barrel, and his small beer from the same grains for 6s. per barrel.

At the present day the brewing trade has reached vast proportions in Great Britain. It would appear that its extent has now attained the *maximum;* the quantity produced for export is likely to decline, as most of the colonies are beginning to make their own. The pale ale of Tasmania deserves particular notice; the climate being specially favourable to hop-growing and malting, that colony not only produces its home-supply, but carries on an export trade with Australia. According to the report to Messrs Bass by Professor Leone Levi, the number of persons employed in and depending on the British liquor trade is 1,500,000, and the capital invested in it amounts to £117,000,000. There are 5000 maltsters, 34,000 licensed brewers, 6000 dealers in ales, and 139,000 publicans. These pay nearly £8,000,000 a year for permission to make and sell the popular drink. The quantity of beer brewed in 1869 was 25,542,664 barrels, of which 521,272 barrels were exported; whilst in 1874 the exports were 573,957 barrels, of the declared value of £2,508,883. It has been estimated that Barclay & Perkins (successors to Thrale, Johnson's friend) have £1,500,000 sunk in their trade. Bass, the largest brewer in the world, pays license on 1,000,000 barrels, and there are eighteen other brewers who pay duty on 200,000 barrels. From the excise official returns we find the annual consumption per head of the population is

In England, 2 bushels of malt, $\frac{1}{2}$ gallon of spirits.
" Scotland, $\frac{7}{10}$ " " $1\frac{1}{2}$ " "
" Ireland, $\frac{4}{10}$ " " $\frac{8}{10}$ " "

The first essay known to us on the subject of brewing is by Basil Valentine. Boerhaave says of this treatise that it is both accurate and elegant. In 1573 H. Knaust published a work in five volumes at Erfurt, with the quaint title, *On the Divine Noble Gift, the Philosophical, highly Dear, and Wondrous Art to Brew Beer.* In the year 1585 Thaddeus Hagecius ab Hayck (a Bohemian), published a treatise entitled *De Cerevisia, ejusque conficiendi ratione, natura, viribus, et facultatibus.* This small work of fifty pages gives a very clear and accurate description of the process of brewing. To Mr Combrune, a London brewer in the earlier part of the 18th century, we are indebted for the proofs he gave of the value of the thermometer in brewing. In other respects his work entitled *The Theory and Practice of Brewing*, is of no particular value at the present day, though it was very useful at the time in advancing the art, and ran through several editions. Previous to his time brewers had looked upon the thermometer as a scientific toy, and "rule of thumb" was the order of the day. In the year 1784 Mr Richardson of Hull brought out his *Theoretic Hints on Brewing Malt Liquor*, and *Statistical Estimates of the Materials of Brewing, showing the use of the Saccharometer.* These works would be beneficial but for the absurd mystery with which the author invests the whole subject. It was he who first brought publicly to the notice of brewers the value of the saccharometer, an improvement of his own on the hydrometer, or water guage, invented by Martin, the Fleet Street mathematician. Mr Baverstock purchased one of these in 1768, and in 1770 received a certificate of the value of his instrument from Mr Thrale, the celebrated brewer in Southwark, who had tested it. It was not, however, till 1785 that Mr Baverstock published his *Hydrometrical Observations and Experiments in the Breweries;* so that Mr Richardson has the merit of bringing his improved hydrometer, which he christened saccharometer, first to the notice of the trade. By this instrument the brewer is enabled to ascertain the amount of saccharine or fermentable matter in the wort, and thus to take advantage of a particularly good sample of malt, or to compensate for a bad one, so as to procure an uniform strength. Malt varies in quality according to season, the skill of the maltster, and other circumstances. Samples of barley raised from the same seed, and grown in adjoining fields, will produce malt widely different, although this is not discovered till it has been in the mash tun. The quantity of malt which suffices for a particular "length" to-day may fall far short of affording the same quantity of ale to morrow, and *vice versa.* In either case the saccharometer is essential, as it enables the brewer to make his ales one standard strength. The instrument is also of great service in regulating the fermentations.

Mr Richardson's saccharometer was constructed on the principle that 36 gallons (one barrel) of water weighs 360 lb, and if that quantity of water were converted into wort

and the scar or eye, through which the seed is nourished during the process. The hard white part is termed, botanically, albumen. This is the cotyledon, and forms the chief part of the seed, supplying the germ with food during the first few days of its existence. With the germ, which begins to exist within an hour of being put in steep, springs also into existence the principle termed diastase. This name (from διίστημι, to separate) was given it by MM. Payen and Persoz, who made numerous experiments with it.

According to Muspratt, diastase may be obtained by making a paste of malted grain at a temperature of 76°, allowing it to stand for a few minutes, and then pressing out the liquor, which is afterwards filtered and heated in a water bath at 170°. At this temperature a portion of the foreign nitrogenous matter coagulates, which is afterwards separated by filtration. The clear filtrate, which contains tolerably pure diastase, is evaporated at a low temperature to dryness. Diastase is not only soluble itself, but has the power of dissolving starch, and converting it into soluble gum, to which is given the name dextrin, and finally into grape sugar, so called because, on analysis, it closely resembles the sugar which naturally exists in the grape. So powerful is diastase, that one part will convert 2000 parts of starch into grape-sugar. This operation will be noticed below under the head of mashing. It is on account of this wonderful power of diastase to convert starch into saccharine matter, that distillers use one part of malt in mashing to five parts of raw grain. The next part of the seed that comes under notice is the corcule, which is the embryo of the future plant. This germ, feeding on the sugar formed from the starch of the cotyledon by the action of diastase, grows upwards and downwards,—the upward growth being the plumule or "acrospire," the downward the radicle or future root. Acetic acid (vinegar), which does not exist in raw grain in a free state, is now also formed; this assists the diastase in its action.

The maltster's object is to obtain as much saccharine matter as possible, with the smallest loss of substance, by converting the starch of the barley into sugar, and thus preparing it for the brewery, where it is changed by fermentation into alcohol. Chemically, starch and sugar are composed of the same elements, carbon, oxygen, and hydrogen; but their atoms are differently arranged,—the mean results of the analyses of Berzelius, Gay-Lussac, and Thenard, giving $\frac{17}{100}$ths of a grain of carbon more in starch than in sugar, whilst sugar contains $\frac{25}{100}$ths of a grain more of oxygen and $\frac{8}{100}$ths less of hydrogen than starch.

The duty on malt forms an important item in the revenue, and stringent laws have been made to enable the excise to levy the duty, and prevent the maltster from defrauding. It may be remarked, however, that although those rules were relaxed or abolished, the process of manufacture would be carried on as it is now. The duty was first raised in the reign of Charles I. on the following scale:—English malt, 4s. 4d.; Scotch barley-malt, 3s. 8½d.; Scotch bigg-malt, 3s. per bushel, but 2s. of this was a war-tax, and the whole was soon repealed. In 1697 a tax was again imposed (to enable William III. to carry on war with France) of 6¾d. per bushel. The rate has been frequently changed, and has ranged between 7d. and 4s. 5¾d. in England, and 7d. and 3s. 9½d. in Scotland. For this and much other information we are indebted to a useful little work on malting published by W. R. Loftus. The present rate of duty on malt made from barley is 2s. 7d. per bushel, and 5 per cent. additional, making in all 2s. 8$\frac{11}{20}$d.; and on malt from bere or bigg, when made for consumption in Scotland or Ireland, 2s., and 5 per cent. additional; when the latter is imported into England the higher duty is charged. The 5 per cent. additional was imposed in 1840 on all exciseable articles, except spirits.

Table showing Quantity of Malt made in Great Britain during the years 1871 to 1874, and the amount of Duty levied:—

	Year.	No. of Bushels.	Duty Levied.
ENGLAND—			
From Barley.	1871	46,318,153	£6,281,899
	1872	51,511,682	6,986,273
	1873	52,873,839	7,171,014
	1874	53,661,020	7,277,775
SCOTLAND—			
From Barley.	1871	2,768,187	375,435
	1872	2,956,040	400,913
	1873	3,171,582	430,146
	1874	2,819,612	382,410
From Bigg...	1871	37,843	3,973
	1872	23,636	2,482
	1873	26,931	2,828
	1874	20,600	2,163
IRELAND—			
From Barley.	1871	2,929,282	397,284
	1872	2,715,412	368,278
	1873	3,365,624	456,463
	1874	3,221,329	436,893
From Bigg...	1871	7,545	792
	1872	7,014	737
	1873	nil.	nil.
	1874	...	...

Malting consists of four processes,—steeping, couching, flooring, and kiln-drying.

Steeping is performed in a large cistern of stone, or more usually brick, covered with cement, into which the barley (properly screened, to remove the small useless grains) is shot from the store-chamber above. It is then levelled and covered with water to the depth of 5 or 6 inches, all floating kernels and refuse being skimmed off. This process is necessary for the germination of the seed not only in a chemical but also in a mechanical point of view. The seed is so hard and compact, and the husk so firmly bound to the kernel, that it would be impossible for the tender germ to make its way through it; the steeping imparts vitality to the germ, and also assists it in making its way through the husk. The grain now swells about one-fifth in bulk and one-half in weight from the moisture absorbed; or more precisely, 100 ℔ of barley would weigh, after steeping, 147 ℔, and 100 bushels measure would increase to 122. By law it has to be kept at least forty hours under water, and fifty if the grain is to be sprinkled before the twelfth day. This time must depend on the kind of barley used, the soil on which it was grown, the heat of the weather, and the hardness or softness of the water in which it is steeped. More time is required in cold than in hot weather. Scotch barley requires more time, but bigg less. Fifty hours steeping will generally suffice, but sometimes seventy is necessary. The rule is—if a barleycorn, held lengthwise between the finger and thumb, breaks down into a pulpy, mealy state, the process is complete; whereas, if the farina exudes in the form of a milky paste, it is over-steeped. In warm weather the steep-water acquires an odour from matter dissolved out of the barley skin; and, in consequence of a slight fermentation caused by the organic matter in the water acting on the decayed grain, the water becomes acescent or putrid. The steep-water should then be changed. This the maltster is allowed to do once during each wetting, upon giving due notice to the Excise. Whilst the barley is in steep it is guaged by the excise officers, to prevent fraud, and to calculate the duty to be paid. Wide planks are placed across the cistern to enable them to take the "dip,"—sufficient light, and headroom of at least 48 inches, being provided. Numerous experiments show that 81½ bushels of good dry barley will, after forty-eight hours steep, swell to exactly 100 bushels. An allowance is therefore made of 18½ per cent. on the grain found in the

cistern or couch frame, but the duty is charged on the greatest amount found, whether in the couch or on the floor or kiln. When the operation of steeping is complete the water is drained off in about half an hour by means of a gutter laid below the level of the cistern from end to end, with a proper fall, and covered with perforated iron plates. The perforated plates being movable, the gutter is easily cleaned and the plates replaced. The law requires that every cistern shall be permanently constructed with the sides and ends straight, and at right angles to each other, for facility of measurement; the depth must not exceed 40 inches in any part; the bottom must be even, with a fall of not more than half an inch per foot for drainage. No cistern can be used under a penalty of £100 until a certificate in writing from the supervisor has been obtained, stating that he has surveyed the utensil, and that it is constructed according to the requirements of law.

Couching.—The couch-frame is formed like the cistern, with the exception that the fourth side may be made of movable planks at least 2 inches in thickness. Before the year 1827 it was lawful to construct the couch-frame entirely of movable boards; and couches made before that date may still be used by obtaining permission from the Board of Inland Revenue. Into this frame the grain is now thrown with wooden shovels. It must not be compressed in any way, under heavy penalties, and must not exceed 30 inches in depth. If the excise officer has any suspicion that the grain has been trodden down, he may order it to be thrown back into the cistern and levelled. The officer will then gauge it again. If he finds that the quantity has increased more than 5 or 6 per cent. according to the length of time the grain has been emptied from the cistern, any such increase over and above the 5 or 6 per cent. will be deemed conclusive evidence that the grain has been trodden or forced together. A penalty of £100 is then incurred; and a like sum for maltsters or their men refusing to return the grain to the cistern. After twenty hours the maltster is at liberty to move the grain on to the floors; but, in cold weather, when sufficient heat to forward germination has not generated, it is left two days, and even longer; but if left too long, the grain becomes sour. After sufficient time has elapsed, in order to prevent the heat rising too rapidly, and to equalize it through the whole body of grain, it is thrown forward on to the floors.

Flooring.—Here the grain must be kept level, with the edges straight to make it easy for the officers to gauge, which is done several times to prevent the introduction of uncharged grain. This operation of gauging requires great care, as, in large houses, a mistake of the tenth of an inch would make a difference of between 20 and 30 bushels to the maltster. On the floors an allowance of one-half is made for the rootlets; this is generally quite sufficient. Each steeping is called a "floor" or piece, and must be laid in succession according to age, the most recent next the couch, and the oldest next the kiln. Maltsters may have six floors, including grain in the couch and on the kiln, in operation at one time. Germination now progresses; the plumule, or stem begins to grow under the husk from the same end as the root, but instead of piercing the husk, turns round and proceeds under it to the other end of the grain. This would develop into the green leaf were its progress not stopped. Maltsters vary as to the length it is advisable to let the acrospire attain; some like it not much more than half up the back of the grain, others like it $\frac{3}{4}$ths or even $\frac{7}{8}$ths of its length, because it is practically found that a friability of the starchy matter takes place *pari passu* with the length of the plumule. Unless the floors are worked with great skill and regularity, however, some are apt to protrude when carried to the latter extent. This shows an exhausted condition within. Maltsters who sell by *weight* work the acrospire no higher than is absolutely necessary; the higher it is worked the less starch and the more sugar is produced, and a corresponding loss in weight ensues. The maltster who sells by *measure*, however, likes to have the acrospire as high as he can, to increase the bulk of his malt. The writer's experience is that ales fine better, and keep better, when brewed from malt well worked up. In large mash tuns, where the heat can be maintained, it is not of so much importance; but in small tuns, where less than twenty quarters are mashed, if the "spire" is up $\frac{7}{8}$ths of the grain, so much the better, so long as it is uniform. The temperature on the floor rises to between 50° and 60°; the fibrils of the radicle, the "chick," as it is technically called, shoot from the tip of every corn. The middle of the floor being the warmest starts soonest; so, after a few hours, the grain is turned or stirred, so as to bring all to a similar state of forwardness. At this point comes the critical test of the maltster's skill; no fixed rules can be laid down; he must be guided by experience and circumstances. He has to consider the quality and growth of the barley,—whether it came off light or heavy soil,—the kind of malt intended to be made,—the temperature and peculiarities of his particular malting. His principal object is to get the grain to work, and to work regularly, to accomplish which, and to check the too rapid growth of the rootlets, the grain must be turned several times daily, the interior being always brought to the surface by the shovels of the workmen. The grain is spread more thinly each time, the depth of it, originally 14 or 15 inches, being thus gradually lessened to 3 or 4. This brings it to the middle of the process; it is then thickened as gradually as it was diminished until it is thrown on the kiln. The grain now emits an agreeable odour, something like apples; and if the hand be thrust into the corn it is found wet enough to damp it; this is called sweating. The "chick" develops into several short bushy rootlets. As the acrospire grows the constituents undergo a great change; the gluten and mucilage almost disappear; the grain becomes white, mealy, and sweet; carbonic acid is produced; air is absorbed, almost as by animals in breathing; and, consequently, air is necessary to the germination of the grain. It loses during this part of the process from $1\frac{1}{2}$ to 3 per cent. in weight.

There can be no doubt that it is of importance to the maltster that the law allows him to sprinkle water over the "pieces" on the floor; this may be done at the expiration of ninety hours after removal from the steep, provided such grain has been kept under water fifty hours. Sprinkling is generally commenced on the fifth or sixth day, notice having been given to the Excise twenty-four hours before. If in steep less than fifty hours it may not be sprinkled till the expiration of twelve days. Sprinkling is used most by maltsters who sell by measure, and therefore want to increase the bulk of their malt; but there are seasons when it would be difficult to make good malt unless moisture were thus supplied, to make up the water lost during sweating. Too much light is detrimental, as appears from the fact that grain under the influence of uninterrupted light is inferior, unless the sky-light be covered with a coating of blue, which admits the actinic rays, and excludes the calorific and light rays, which hinder germination. Shutters on the sliding principle are the best for regulating both light and heat. Great care has to be taken not to damage the grain by turning, especially when it is spread thin. To obviate the necessity of turning as much as possible an instrument like a narrow shovel, called a plough, is used, which brings the grains underneath to the surface, and into contact with the cold air, so keeping the germination

regular. Grain is required by law to be kept at least 168 hours on the floors, but maltsters may keep it there as much longer as they like. Barley throws out five rootlets, the middle one being the strongest; and if the young floor has been neglected, this will shoot out three times the length of the others and turn up at the end like an awl. When the grain has germinated sufficiently, its growth is arrested by placing it on the kiln, the object being to drive off superfluous moisture and insure the keeping qualities of the malt.

Kiln-drying.—The kiln is a chamber of which the floor should be made of woven-wire or sheet-iron, or of perforated tiles. The perforations are necessary to give admission to the hot air, and also to allow the detached rootlets to fall through. The kiln should have a sufficient area to allow the whole of one steeping to be dried at once, at a depth of 8 or 10 inches; by which means the malt is more regular than when dried in two or three lots, as the portion left on the floor will grow, notwithstanding the maltster's efforts to prevent it. The opening at the top of the kiln is covered with a cowl or cupola, which answers the double purpose of excluding rain and allowing the escape of the steam. The furnaces are placed under the floor, nearly in the central line, and the hot air passing through the perforations dries the malt, while the steam is carried off through the vent in the roof. An iron or stone plate, 4 or 5 feet square, called the "disperser," is placed over each fire to disperse the heat and prevent the malt immediately above from taking fire. The heat at first should not exceed 90°; if higher it produces a hardening or vitrifaction of the starchy matter or dextrin, and also heightens the colour of the malt; whereas, if the malt be freed from moisture at a low temperature it may afterwards be exposed to a high heat without gaining colour. The moisture being disposed of, the heat may be gradually raised to from 125° to 135° for India pale ale malt, and to 170° or 180° for ordinary pale malt,—the difference in the kinds of malt being the amount of heat to which they are subjected on the kiln. During the process the fires should never be allowed to go out, as the smell of a green fire imparts an unpleasant flavour. During the last few hours in particular there should be a bright, clear fire for finishing off the malt, otherwise the beer will not get bright. It will thus be seen that the process of kiln-drying is very important. Dr Ure's remarks on it are pregnant with meaning. He says, "The operation of kiln-drying is not confined to the mere expulsion of the moisture from the germinated seeds, but it serves to convert into sugar a portion of the starch which remains unchanged, and that in a two-fold way. This is, first, by the action of the gluten upon the fecula at an elevated temperature, as also by the species of roasting which the starch undergoes, and which renders it of a gummy nature. If we dry one portion of the malt in a naturally dry atmosphere, and another on a moderately warm kiln, the former will yield less saccharine matter than the latter. Moreover, the kiln-dried malt has a peculiar agreeable and faintly burnt taste,—probably from a small portion of the empyreumatic oil formed in the husk, which not only imparts its flavour to the beer, but also contributes to its preservation." Kiln-drying takes from one to four days, according to the depth of malt and amount of heat used. The fire being kept always burning, great care is needed to prevent its breaking out in the night; it is therefore made up the last thing and then "banked up," that is, covered with a quantity of the ashes which fall through the bars. For ordinary pale malt, about three hours before it is thrown off the kiln the heat is raised from 150° to 180°, and during this process it requires turning two or three times, and is thrown off the kiln in a hot state. The rootlets are readily detached from the malt by the turning on the kiln, and the treading of the men in their list slippers; they are finally separated by screening, and are the best criterion of the colour of the malt, showing at once the amount of heat used. These malt "combs" or "cummings," as they are called, are valuable food for cattle in winter; and the fine ones which fall through the kiln-floor on the disperser, mixed with the dust from the fire, are said to be almost equal to Peruvian guano as a top dressing for turnips.

Malt continues to swell, by absorbing moisture from the atmosphere, for nearly three months, the time varying according to the dampness of the air. Malt in store is said to be mellowing. The increase by measure of malt over dry barley, called the "outcast," is from 3 to 8 per cent.; in bigg the increase scarcely amounts to 1 per cent. During the process of malting barley loses one-fifth of its weight; in other words, 100 ℔ of barley converted into pale malt weighs on an average 80 ℔: but as barley when kiln-dried loses 12 per cent. of moisture, the actual loss is reckoned at only 8 per cent. The late Professor Thomson thus accounted for it:—

Soluble matter carried off by steep-water	1·5
Carbonic acid formed and given off during germination	3·0
Roots	3·0
Waste (bruised and lost grains)	0·5
	8·0

Dr R. D. Thomson, who made various experiments on malt for the purpose of ascertaining its feeding and fattening properties, states the loss sustained to be

Water	6·00
Saline matter	0·48
Organic „	12·52
	19·00

Bigg sustains a greater loss than barley, amounting to 7 per cent. more. The great similarity which chemical analysis shows to exist between barley and malt, proves that malting is only the beginning of the process by which saccharine matter in solution is obtained. A glance at Stein's analysis of the two will show this:—

	Barley.	Malt.
Soluble albuminous compounds	1·258	1·985
Insoluble „ „	10·928	9·771
Husk	19·854	18·817
Dextrin	6·500	8·232
Fatty matter	3·556	3·379
Inorganic matter	2·421	2·291
Extractive matter	0·896	4·654
Starch	54·282	50·871
Loss	·305	...
	100·000	100·000

The following is the composition of barley and malt, as given by Oudemans:—

	Barley.	Malt.		
	Air-dried.	Air-dried.	Kiln-dried Pale.	Kiln-dried Amber.
Produce of torrification	0·0	0·0	7·8	14·0
Dextrin	5·6	8·0	6·6	10·2
Starch	67·0	58·5	58·5	47·6
Sugar	0·0	0·5	0·7	0·9
Cellulose	9·6	14·4	10·8	11·5
Albuminous substances	12·1	13·6	10·5	10·5
Fatty „	2·6	2·2	2·4	2·6
Ash, &c.	3·1	3·2	2·7	2·7
	100·0	100·0	100·0	100·0

Albuminous compounds in barley and malt (Oudemans)—

	Barley.	Malt.
Gluten soluble in Alcohol	0·28	0·34
Albuminous substances coagulable	0·28	0·45
Albuminous substances not coagulable by heat	1·55	2·08
Insoluble Albumen	7·59	6·23
	9·70	9·10

There are three kinds of kiln-dried malt—pale, amber, and brown, and one of roasted, called black or patent malt. We have already seen how pale East India malt is made; also that the ordinary pale malt is dried off at a higher temperature by 30° or 40°.

Amber malt, when ground, is of a rich amber colour, hence its name. This is dried off at a heat of 180°. The fuel used during drying is different. For pale malt, coke or anthracite coal is used, but the colour and flavour of amber malt are produced by burning oak or other hard-wood faggots,—the flavour being caused by the pyroligneous acid thrown off during burning. High-coloured malts have advantages over pale; more dextrin is produced and more albuminous matter is rendered insoluble; it is, therefore, easier to brew good beer from them.

Brown or porter malt is dried in yet another way. The floors of malt-kilns used for drying it must be made of thin sheet-iron or stout wire, as the heat must be raised in a few minutes from 100° to a heat nearly approaching combustion, and lowered as rapidly. The process requires great attention, or the malt would take fire. The grain is spread thin, not exceeding 1½ inches in depth; and the whole process is completed in less than two hours. The fuel used consists of faggots of beech, elm, or oak; at first the fire is kept down by being sprinkled with water, but the last half-hour it is allowed to increase, and an intense heat is obtained. This kind of malt weighs about 32 ℔ per bushel. It is sometimes called "blown malt," from its distended appearance. By this process the gum, sugar, and starch are converted into a kind of caramel, which gives the flavour so much prized in porter. It makes the malt, however, deficient in extractive matter, to the extent of from 20 to 30 per cent.

Patent malt, which is the legal colouring-matter in porter, is made and charged with duty in the same way as other malt, and then removed to the roasting premises, where it is treated like coffee, being roasted over a fire in cylinders of perforated iron. The law requires that 95 per cent. of this malt shall have the "spire" extend to one-half the length of the grain in order to prevent the introduction of raw grain. It is generally made from injured or inferior malt, as the high temperature in drying quite restores the appearance. There is, of course, no saccharine extract from it, that having been converted into caramel or burnt-sugar; it is only wanted to supply colour and flavour. Good malt of this kind should have each grain distinct, of its own original size and shape, not adhering to each other; and when it is bitten the inside should be of a rich chocolate colour.

Pale malt differs in appearance from barley; the grains are plump and generally free from wrinkles, and paler than barley. Instead of the tightly-closed end, the opening through which the rootlets have passed is visible at the base of each grain; when broken the starch should be loose, friable, and cretaceous, and should leave a white mark as of chalk when drawn along a black surface. It should be crisp to the teeth, and have a sweet and empyreumatic flavour, free from the least mould or mustiness of smell or taste. Malt should weigh from 39 ℔ to 43 ℔ per bushel. There should be no vitrified appearance when broken; that would be due to an excess of heat at the beginning of the drying process, or to the barley having been grown in too rich a soil, or to mixed seed being used which did not work regularly. A good test is to take 100 seeds and throw them into water, stirring them well up; good malt, being specifically lighter than water, should float on the surface; if more than 5 per cent. sink it is bad malt. Another test is to take 100 grains of malt and carefully examine the regularity of their acrospire, which should extend ⅔ths of the length of the grain for large and ⅞ths for small brewers. If more than 5 per cent. have projected it shows a waste of material, whereas if more than 5 per cent. have the acrospire less than half way up, it is a sign of insufficient germination.

Dr Ure's analysis goes to show the amount of solid extract obtainable by the brewer. He takes 100 grains of malt by weight, which are powdered and dried half-an-hour by the heat from boiling water; they are then weighed, and the loss shows the quantity of moisture in the malt. This powder is then mixed with cold water, and the vessel containing it is heated in the steam-bath half an hour, the contents being occasionally stirred. The husk and insoluble matters are then drained off, washed with boiled water, and then dried and weighed,—their weight giving the insoluble matter in the malt, and the residue the soluble extract available to the brewer. Dr Ure found in several experiments the average in 100 parts by weight, to be—

Moisture	6·5
Insoluble matter	26·7
Soluble extract	66·8
	100·0

According to this, if we assume that a quarter of malt weighs 324 ℔, the total soluble extract will be 216·4 ℔ avoirdupois; but as the gum and sugar in assuming the fluid form combine with the elements of water, if the extract were dried it would weigh 23 ℔; and being reduced to the basis of the barrel of 36 gallons would become, in the language of brewers, 87 ℔ extract per barrel, which means that, if the wort from a quarter of malt were evaporated down to the bulk of a barrel of 36 gallons, it would weigh 87 ℔ more than a barrel of pure water. Practice shows these experiments to be correct, the extract per quarter varying, according to the sample of malt, from 80 ℔ to 90 ℔.

Malt is made duty-free for distillery purposes and exportation; in both cases the maltster has to enter into a bond with two sureties for £1000 that the malt goes to its declared destination. It may also be made free of duty for cattle feeding, an Act giving great facilities being passed in 1864; it was, however, found to be useless, except in small quantities, as a condiment, and the practice of giving it is entirely discontinued. In 1870 there was not a single bushel made, as there was no demand for it. In the case of malt damaged by fire or water, an allowance equal to the whole of the duty, if totally destroyed, or part if the damaged malt be sold on salvage, is granted by 7 and 8 Geo. IV. c. 52, § 76. The duty on malt is payable at the end of every six weeks, but upon entering into a bond with sureties for payment, a maltster is allowed six weeks' credit. Also by 26 Vict. c. 6, § 1, he may defer payment of half the duty on malt made between 1st January and 1st April, and the whole of the duty on malt made between the latter date and 16th May, for three months, on giving notice of his intention to the proper collector before 1st April, paying interest at the rate of 3½ per cent. per annum for the accommodation, and giving bond for security.

By 7 and 8 Geo. IV. c. 52, § 46, it is provided that, if any workman, maliciously or otherwise, commits an act by which his employers are liable to a penalty, he shall be imprisoned with hard labour for not less than three or more than twelve months. The master is liable for these

penalties incurred by the workman unless he prosecute his servant within a month of the offence, and show the Commissioners a certificate of such conviction. Some maltsters have a notice put up in their maltings to the effect that their men will be prosecuted if they commit the offences mentioned in the Act.

In America there are no internal taxes on materials used in brewing as such, but there is an import duty on hops and barley,—five cents per ℔ on the former, and 15 cents on the latter per bushel. The barley mostly used comes from Canada, the import duty being equal to about 1s. 4d. on an American barrel of beer. The duty is levied in the form of a stamp-tax on the beer fermented, completed, and in barrel, at the rate of $1 per barrel of 31 gallons, and $2 per barrel of not less than 63 gallons. No restrictions are imposed as to the materials of which it shall be made.

In Bavaria the duty is raised on malt, but not assessed till the malt is brought to the mill to be crushed. It is made without licence or permission, and may be sold without restriction; but traffic in ground malt is strictly forbidden. The case is the same whether the malt is used by brewers or distillers. The consumption of beer and spirits is untaxed, except through the impost on malt. The means adopted for preventing fraud consist exclusively in the control exercised in the public mills by the Government inspectors. Private mills for crushing malt are only allowed when the proprietors have their mills furnished with the regulation self-acting measuring apparatus, together with the Government automatical counter. This apparatus is sealed officially, and thus it is impossible for an ounce of malt to be crushed which has not first been measured and checked. Besides these means for preventing fraud, there exists a regulation that no malt, whether tax-free or not, may be brought to any mill, or be found there, for which a certificate (polette) has not been given specifying the date, the quality, and the mill.

Americans are now making beer largely from maize meal and maize malt. The experience the writer has had of the use of the latter leads him to doubt its economy; the extract is small, and the fine flavour of the ale impaired. However, a small quantity can be used with advantage where the fermentations are sluggish or inactive,—maize being the most powerful stimulant of this process that we possess. Barley has always been considered, and with good reason, a better, and in favourable seasons a cheaper, grain than any other for malting. The reasons for this are, first, that whilst the husk permits the steep-water to pass through to the starch it effectually precludes the escape of the starch; secondly, the acrospire grows under the husk in barley, and so is protected from injury during malting, whereas in wheat, maize, &c., the acrospire forces its way out with and at the same end as the rootlets, and therefore runs the risk of being damaged by turning on the floors; these damaged grains become mouldy, and mould being propagated by means of spores, one mouldy grain may send out thousands of these spores among the good grain, and infect the previously healthy ones; and thirdly, barley contains a large ready-made proportion of grape-sugar and starch. It is, therefore, only in bad barley seasons that there will be much demand for malt made from other grain. The average price of barley from 1872 to 1875 has been 43s., and in 1874 the average was as high as 49s. This high price, which means a material increase in the cost of manufacture, has naturally made a great inquiry for a cheaper sugar-forming product; and there is no doubt that if the duty on malt were either taken off or laid on the manufactured article, beer, large quantities of other grain dried on a kiln at from 230° to 240° would be used in bad barley seasons. In Germany the grain is steeped before kiln-drying for three or four hours, to remove from the husk the unpleasant flavour it sometimes imparts to ales; the materials used to a considerable extent there are wheat, oats, rice, maize, and even potato starch. Beer made from rice is of a very clear pale colour, of an extremely pleasant, mild taste, foaming strongly, and yet retaining its carbonic acid. Dr Graham, in his instructive lectures on the chemistry of brewing, at the Society of Arts in 1874, explained how raw grain might be used to obtain a beer either alcoholic in its nature, as brewed in England, or dextrinous, like the Bavarian beer. Mr John Prior, of the firm of Truman and Hanbury, in his examination before a committee of the House of Commons, says, "If the malt Acts were not in the way, numerous substitutes for malt might be employed," and that, amongst these, mangel-wurzel might be used to any extent; and he goes on to say, "I have tasted as good beer brewed from that alone as any home-brewed beer I have ever tasted in my life."

The only substitute for malt allowed in Great Britain is sugar. Of this, in its different forms, there was used in the year ending September 30, 1874—

		Cwts.
In England	London	283,736
	Provinces	422,136
		705,872
In Scotland		7,323
In Ireland		54,825
		768,020

being an increase over 1873 of 204,528 cwt. Sugar may be used in brewing to the extent of one-third,—two cwt. being equal to a quarter of malt; the duty is 11s. 6d. per cwt. It is either boiled with the wort, or dissolved in the underback. Ordinary cane-sugar contains a large amount of dangerous putrefying albuminous matter. It may also be said to cause two distinct fermentations, having to be converted, by the action of the ferment, into glucose before it is broken up into alcohol; it is, therefore, only good for ales of quick consumption. For store ales it is as well to destroy one of these fermentations, and at the same time convert the cane into grape-sugar or glucose. This is done by treating it with dilute sulphuric acid, the acid being afterwards got rid of by means of chalk or lime, which combines with and carries it down. This is effected very rapidly if the temperature be increased by pressure to 250° or 300°, 1 ℔ of acid mixed with 600 ℔ of water converting 100 ℔ of starch or cane-sugar into glucose in three hours. This action of acids upon cane-sugar has formed the subject of a patent (Garton's), which is being worked on a large scale at Southampton, and the product is sold under the name of saccharine; it has found great favour with brewers, as it gives a rounder flavour, and more permanent character, to the beers than when brewed from malt alone, and at the same time masks the acidity where any exists, better than starch or cane-sugar. Saccharine has been carefully analysed, and the analysis shows the whole of the raw sugar to have been converted into glucose with a certain percentage of water. The best mode of distinguishing grape from cane-sugar is by adding to the solution to be tested, in a flask, a few drops of an alkaline solution of tartrate of copper, and then gently boiling it. If any grape-sugar is present a bright red metallic-looking precipitate of suboxide of copper is shortly thrown down; if no grape-sugar is present the solution remains clear, with a slight blue tinge, from the addition of the copper solution.

It does not appear that the best judge can, from the taste alone, distinguish between a beer made from malt and one brewed from a mixture of malt and sugar. This is not surprising, when it is borne in mind that brewing from malt consists in subjecting the malt to those condi-

tions which are most favourable to the conversion of the *maximum* quantity of the starch it contains into grape-sugar, by the action of the diastase produced in the grain by the process of malting.

Hops are the catkins or flowers of the *Humulus Lupulus*, a diœcious plant belonging to the natural order *Urticaceæ*, or the nettle family, and the Linnæan *Diœcia pentandria*. It is the female flowers (which grow on different plants from the male flowers) that yield the hop known to commerce. The plant is mentioned by Pliny under the name of *lupus salictarius* (*N. H.*, xxi. 50). It was cultivated in the 9th century, for we find that in 822 the millers of Corbey were freed by the abbot from all labours relating to hops; and hop-gardens are mentioned by Ludovicus Germanicus, a few years later. Hops were introduced into England from Flanders about the time of Henry IV. There is a curious edict of Henry VIII., forbidding the mixture of either hops or sulphur with beer; but little attention seems to have been paid to it, for in 1552 hop-plantations were formed. In 1649 the city of London petitioned Parliament against "hoppes" being used, urging that "this wicked weed would spoil the drink, and endanger the lives of the people." It came into common use in Queen Elizabeth's reign.

The hop-clusters are ovoid cones, consisting of scales which are the enlarged persistent bracts enclosing the fruit. They are covered with a tenacious yellow, waxy substance, like powder, called lupulin, and technically "condition." Under the microscope this is seen to consist of minute semi-transparent granules, round in shape; it is the most valuable part of the hop, containing most of its active properties. The amount of powder compared with the total weight of the hop varies from 10 to 15 or even 20 per cent. Amongst the leaves and powder of the hop, we find essential oils, resin with associated bitter principles, and tannin. When distilled with water, the powder gives 2 per cent. of its weight in essential oils (there is none in the leaves); one of these distils at 212° Fahr., but the other requires a much higher temperature for its volatilization. Other products are formed from the lupulin—among them valerianic acid, which is the disagreeable characteristic of old hops. The essential oils not only give the aroma, but are of importance, as through their combination the resins and bitter substances become soluble in water. The resin constitutes 50 per cent. of the powder, and is soluble in alcohol. The importance of tannin consists in its power to precipitate albuminous matter; of tannin there is only about 2 per cent. It has been suggested to increase this by using the tannic acid of commerce as a partial substitute for hops; and experiments have been made in Dresden by Dr Fleck for this purpose. This must, however, be used with caution, as an excess of it would be prejudicial to a successful clarification of the beer.

The most delicate hops are Goldings, grown in East Kent,—Farnham and Worcester districts being next best, while good, strong, serviceable hops are grown in the Weald of Kent, Sussex, &c. Large quantities are imported from Germany, Belgium, America, &c., the best being Bohemian, grown near Saaz, which are very excellent in delicacy of flavour and aroma; Bavarians grown in the district round Spalt are valuable for their cleansing and beer-keeping qualities.

The acreage under hops in England is 65,000,—40,000 being in Kent. This is an increase of more than 15,000 acres since the commutation of the duty in 1862. In that year the duty was taken off hops, and a charge made on brewers of 1s. per quarter, being at the rate of 3d. per barrel, on the supposition that four barrels of beer were drawn from every quarter mashed. The old duty was 2d. per ℔ and 5 per cent. additional. A hop-garden costs from £70 to £100 to start, and from £27 to £30 to farm per annum. A rich, deep soil, rather inclined to moisture, is, on the whole, the best adapted for the crop; but any soil (stiff clay only excepted) will suit, when properly prepared. It should be enriched with the kind of manure best suited to the land the hops are to be grown on; stable and cowhouse dung, old rags, shoddy, guano, sprats, and other decomposed matter are used freely; while on some land peat and lime are required. The land is first rendered fine and mellow by being ploughed and harrowed several times; then, in the spring, a large hole is made and filled with rich mellow earth; into this "sets" or small pieces of the roots of the kind of hop intended to be grown are planted with the buds uppermost and the earth pressed close about them. These sets take three years to come to perfection. Two or three sets to a pole, three poles to a hill, 1050 hills to an acre, is the usual calculation. The hills should be 6 or 8 feet apart, the latter being best on rich land, as there the bine runs the most. The poles are from 12 to 18 feet high, according to the adaptability of the ground for vigorous growth, with the ends that go into the earth charred to preserve them. In America the hop is trained on wires; this has also been introduced into England,—Mr Farmer, of Worcester, having taken out a patent. It is very successful, but the first cost, £75 per acre, has prevented its being used extensively. The hop crop is a most precarious one, and may be said to vary from nothing up to a ton or even 25 cwt. per acre, and in price from £3 to £25 per cwt. In proof of this, at the annual Worcester Fair in 1874, only 74 pockets were on sale, whereas the year before 1000 pockets were in the market, and 2000 more were offered for sale by sample.

The plant is very dependent on the season, and has many enemies in the insect world, in particular, the fly or aphis, which infests the crop early in its growth, feeding upon its juices and leaves, giving the latter the appearance of having been riddled with swan shot. The flies come originally from the sloe bushes, and are produced from eggs deposited in the previous autumn. These, as well as fleas, red spiders, lice, &c., may be destroyed by syringing the plants well with soft soap and water. The mould first betrays itself in yellow and drooping leaves, finally in the hop itself, eating it up with mildew,—the presence of a few half-eaten leaves spoiling a sample. The blight coats the leaves with a thick sooty substance; and when this appears the hop dwindles away. The fire-blast, as its name implies, sears and scorches the foliage, and withers it up. All these may be seen working mischief at once in the same hop garden.

The catkins of the hop ripen early in September; they are picked from the bine by thousands of people from London, &c., whose welfare and accommodation have been much neglected; but great changes in this respect are made by sanitary regulations which come into force this season (1875). Besides these strangers, every man, woman, and child of the resident population is made available for the season, which generally lasts three weeks. The pay is about 2d. per bushel; and in a good season a family can make 2s. 6d. a day per head.

After picking, the hops are dried on a kiln (oast-house, as its called),—the heat never being allowed to rise above 90°, lest the aroma and volatile oil should be thrown off. A small portion of sulphur is sometimes added to the fire, the appearance of the sample being improved by the sulphurous acid thus formed. This has been generally considered by brewers injurious to the hop, and also to fermentation; but a commission appointed by the Bavarian Government in 1855 (the late Professor Liebig being one of its members), after two years of experiments, arrived at

the conclusion that the use of sulphur was beneficial to the hop, and not injurious to fermentation. It is frequently used while the plant is growing to cure the various diseases to which the hop, like the vine, is liable. The last process before the hops are brought to market is "bagging." This used to be done by "footing," that is, letting the empty bag drop through a hole in the floor, and having the hops stamped down by one man, whilst two others filled; after which they were pressed by hydraulic power. Under a new process the whole operation is effected by machinery in about eight minutes. Hop-growers, as a rule, have no stores or convenience for warehousing hops for more than a month or two; the consequence is the whole growth, whether large or small, gets into the hands of a few great hop merchants, who command the market.

The best hops have a yellow, golden colour, and an agreeable smell; when rubbed between the hands they leave a yellow, odoriferous, sticky powder on them, without any broken parts of the leaves, and yield to boiling alcohol from 12 to 15 per cent. of soluble yellow matter. A very pale green colour indicates that the hops have been gathered before they are fit; whilst a deep brown shade would show they were allowed to hang too long before being gathered, or that they have been over dried on the oast-house floor. A fair test in choosing hops for India pale ale is to make a strong decoction of them with boiling water, putting it into a white bottle, corked and exposed to the sun; if in twenty-four hours the colour has become dark they are not fit for the purpose.

During the year 1852 only 34,622 ℔ of foreign hops were imported; in 1853 this increased to 4,739,307 ℔, and in 1871 to 24,685,808. Before the hop-duty was taken off there was a great deal of betting on the crop, which was computed as equal to so much duty; and the appearance in the Borough of a hop leaf covered with fly from one of the most favoured districts used to cause much consternation. Since the repeal of the duty brewers have been allowed to use any bitter instead of hop, provided such bitter does not give a factitious strength to beer, and thus become a substitute for malt. Many preparations are, in consequence, offered for sale as partial substitutes for hops; but in these none of the noxious, forbidden articles, such as *Cocculus indicus*, &c., &c., are found, for we learn from the laboratory returns of the Inland Revenue that, in the year 1872, only six samples of beer tested were found to be adulterated. Considering the enormous extent of our brewing industry (it is calculated that 900,000,000 gallons of beer are brewed annually), such testimony to the purity of the beer is highly creditable to those engaged in the trade. From the same source, we learn that in every instance where an adulterant of a dangerous nature was used, the offending parties have been those who brewed and retailed their own beer on a very small scale.

Age alters and deteriorates the character of hops in a marked and distinct degree, much more so than in most aromatic substances; indeed, it changes them to such an extent that, at the end of two years (when they are called "old olds"), they retain little but the bitter, the aroma being gone.

In the year ending 30th September 1874, the hops imported into Great Britain were—

	Cwt.
From Belgium	60,338
„ Germany	39,459
„ Holland	16,035
„ United States	2,809
„ Other countries	4,875
	123,516

being a decrease on 1873 of 11,626 cwt.

Hops are grown with success in Tasmania, upwards of 450 acres being under cultivation. The Australian market, it is supposed, will be eventually supplied from thence. At present between 600 and 700 tons of hops are exported from England yearly.

Water.—Pure water, protoxide of hydrogen, is obtainable only by art; it is therefore impossible, even were it desirable, to use that in brewing. But good water is an indispensable element in the manufacture of good beer. It should be hard and free from organic matter; this last point cannot be urged too strongly, as this alone frequently causes failure in brewing operations. From Cohn's investigations we find that the germs of putrefaction are so small that no filter of charcoal or other material removes them. It is also doubtful if ordinary boiling destroys these organisms. Pasteur asserts they are not killed below a temperature of 100° C. (=212° Fahr.); and Lex found them alive after heating to 260° Fahr. Water charged with them is a decided loss to the brewer, as the organic matter is decomposed during brewing and carries off some portion of the strength of the worts, besides making the beer liable to spoil. Soft water, or water that has flowed through moorland, and is free from saline matter, is bad for the brewer's purpose. When this has to be used for want of a better it should be impregnated at second hand with chloride of sodium (common salt) and gypsum (sulphate of lime). To allow for the deficiency of salt in some water the Excise allow brewers to add sufficient salt to make up, with that naturally in the water, 50 grains per imperial gallon. Soft water gives greater extracts, as it dissolves the albuminous matter in the malt more effectually than hard. With the use of very soft water as much as 100 ℔ of extract per quarter has been obtained; but here the goodness of the extract was the chief proof of the badness of the water; for it is dangerous to have too much albuminous matter in solution, except in the case of porter or ale that is quickly consumed, albuminous bodies being such powerful agents of change. Hence the Burton brewers, whose beers have to stand a long time, and in all climates, are perfectly right in praising their water, which contains a large proportion of these mineral salts. The supposed superiority of the Burton ales is due to the water, which is supplied, not from the River Trent, but from wells 20 to 120 feet deep. These wells are supplied from springs rising in the Outwood hills that form the western side of the valley. The springs take up lime in their passage through the gypseous deposits contained in the keuper marls of the district. The presence of sulphates and carbonates of lime and the absence of organic matter make the water of that district so advantageous for brewing. The following is an analysis of the water used in one of the largest breweries in Burton, showing the amount of ingredients in the imperial gallon, represented in grains:—

Chloride of Sodium	10·12
Sulphate of Potash	7·65
„ Lime	18·96
„ Magnesia	9·95
Carbonate of Lime	15·51
„ Magnesia	1·70
„ Iron	0·60
Silicic acid	0·79
	65·28

The water of another large firm in the same town gives by analysis 54·5 grains of sulphate, and 9·93 of carbonate of lime. The temperature of water used to be a great consideration for refrigerating the worts; but this is now of little consequence, as in most large breweries the water used for that purpose is first brought to a point just above freezing, by means of ether spray.

We now come to the actual process of brewing, or the

art of making the materials we have described into beer. While brewing cannot be considered a difficult or a mysterious art,—good materials, a good method, and strict attention being the secrets of success—there is no process in which rules are of less avail. To obtain complete success, it is necessary that the brewer shall have formed an opinion of his materials from personal observation, and that he should be thoroughly acquainted with the brewery in which they are to be used. It is not too much to say, that the same heats and quantities cannot properly be used in any two breweries. Bearing this difficulty in mind, we shall endeavour to point out where instructions may be safely followed, and where the circumstances of locality, &c., will subject them to certain modifications which cannot be strictly defined in an article like the present.

Brewing consists of eight distinct processes, which may be classed as follows:—

1. Grinding.	5. Cooling.
2. Mashing.	6. Fermenting.
3. Sparging.	7. Cleansing.
4. Boiling.	8. Racking and storing.

Grinding.—This is a very important operation; for, if imperfectly performed, some of the "goodness," or "extract" as it is called, will be left in the grains after mashing, thus entailing a heavy pecuniary loss on the brewer. The malt is crushed rather than ground between plain metal rollers; this is enforced by law, for the purpose of facilitating the examination of the grain as to whether it has been malted or not. Previous to the passing of the Act fraudulent brewers mixed raw grain with their malt, grinding it all up fine, to prevent identification. Each corn should be well broken, that the mashing water may have free access to every particle; on the other hand, if the malt be ground too fine, it is liable to "set," that is, form a paste in the mash tun. When this happens it will be difficult to draw the wort off, and when off it will contain so much of the coarser portion of the grain that the flavour and keeping qualities of the beer will be impaired. If possible the crushed malt should stand about twenty-four hours before being mashed, care being taken to protect it from air or damp,—the object being to allow the heat generated by passing through the rollers to escape.

Mashing is the process of infusion, or mixing the malt with water at such a temperature as shall not only extract the saccharine matter existing in the malt, but shall also change the still unconverted starch into grape-sugar. This is accomplished by the principle called diastase, the power of which we have shown under the head of malting. Many mashing-machines have been invented, and many are in use. In some the malt and the water are simply brought into conjunction, and then mix themselves as they fall into the mash-tun; others, driven by steam, perform the operation of mixing more leisurely, and, in some cases, more effectually. The old-fashioned method of mashing is by means of iron rakes. These rakes are fixed on arms extending from the centre of the tun, and are so constructed that when set in motion, no portion of the mash escapes them. When rakes are used a portion of the mashing water is first run into the tun, and part of the malt; the machinery is then started, and, whilst the rakes revolve round the tun, the remainder of the malt and water are added. The heat of the mashing water is a very important point; the particular temperature must depend upon the quantity and quality of the malt, and the situation of and amount of radiation from the mash-tun. Not less than two or more than three barrels of water should be run on to every quarter of malt, and the heat of the water should be such, that, when all has run on, that is, when the malt has combined with the water, the temperature of the mash shall not be lower than 148° or higher than 152°. In some breweries this result will be obtained by mashing at 168°; in others it will be necessary to go as high as 180°. Neither of these heats will do any harm so long as the heat of the mash does not exceed 152°. Most brewers and chemists think that, to ensure the best results, it is necessary for the mash to stand at least two hours. It would appear, however, that this belief has no solid foundation. Recent observations have convinced the present writer that an extract as good, and perhaps sounder, is drawn from a five minutes' mash as from one that has stood two hours,—a fact which any brewer can test for himself. The wort should be drawn off by means of several pipes running from different parts of the mash-tun. It must be run off slowly at first, or the malt in the tun ("goods," as it is now called) will be drawn down so tightly that it will be difficult for the sparging water to run through it. It is a good plan to probe the mash now and then with a thin stick; if the "goods" feel tight, and difficult to penetrate, the wort is being run off too quickly.

Sparging.—When about half the wort has run off the mash, the operation of sparging should be commenced,—the object of that process being to wash out the goodness left in the malt after mashing. The sparging-machine is made and fixed as follows:—A bar of iron having an upright pin in the centre is fixed across the mash-tun; on this pin is placed a copper bowl or pan; into this pan are screwed two or three arms, extending to the sides of the tun. These arms are about an inch and a half in diameter, and are perforated their whole length with small holes on their reverse side. The hot water being conveyed into the pan fills the arms, and, running out through the perforated holes, causes the arms to revolve round the tun. By this means an equal and continuous shower of hot water is rained upon every portion of the goods. The heat of the sparging water, like that of the mashing liquor, must be modified by circumstances. In brews of less than 10 quarters, 200° will be found to be a good heat; where larger quantities are mashed 185° may be recommended as a safe temperature.

Boiling.—When the wort runs off the mash no time should be lost in getting it into the copper or boiling back. In many modern breweries the mash-tun is placed immediately over the copper, so that the wort runs direct from the former utensil into the latter. Some coppers are built with an ordinary furnace, others are furnished with a coil; in the latter case the worts are boiled by steam passing through the coil from the boiler. Many brewers prefer to boil by steam, as it is a cleaner method, and they are able to regulate the operation to a nicety. Where the steam coil is used the boiling back is generally made of wood. While the wort is running or being pumped into the copper, the hops must be added. Here, again, no positive instructions as to quantity can be given. On this point the brewer must be guided by his customers' tastes, the season of the year, the length of time the beer has to be kept, and the quality of the hop used. For strong store ales, from 10 ℔ to 13 ℔ of good hops to every quarter of malt is not too much; whilst for ordinary beers, to be drunk within two months, from 6 ℔ to 9 ℔ per quarter should suffice. India pale ale and bitter beer require from 18 ℔ to 25 ℔ per quarter. Various kinds of English and foreign hops can be used in the same brewing with advantage; the proportions of each kind must be left to the judgment of the operator. Of course, the ranker Bavarian and American hops must not be so freely used as the more delicate English growths. There is a wide difference of opinion as to the length of time beer should be boiled. For beers of quick draught, an hour and a half

is long enough; stock ales should have half an hour or an hour extra. The finest pale ale is never boiled longer than one hour. Where it is necessary to have two boilings in one brewing, the second copper should boil rather longer than the first. The boiling during the first twenty minutes should be brisk, in order to break the wort.

Cooling.—When the wort has boiled the necessary time, it is turned into the hop-back to settle. The hop-back is a utensil made of wood or iron, and fitted with a false bottom of perforated plates; these plates retain the hops in the back, whilst the wort is drawn off into the coolers. The wort should be allowed fifteen or twenty minutes to settle in the back, and when run on to the coolers should be thoroughly bright. In many breweries coolers are not used, the wort running direct from the hop-back through the refrigerator into the fermenting tun. When practicable this is an excellent plan, for worts often take harm whilst lying exposed on the coolers. In every brewery of any note the worts are cooled artificially by means of a refrigerator. Of these there are several kinds, but all are constructed upon the same principle, which is that of allowing a thin stream of wort to trickle over pipes containing a running stream of water. The water is either run direct from the mains or is pumped by an engine from a well. In every instance it is necessary that the water shall be several degrees colder than the heat the wort is to be "pitched" at, as brewers call it, in other words, the heat at which the wort is let down into the fermenting tun. This "pitching heat" varies very much. Beers pitched at high heats, say from 62° to 66°, come soonest into condition, but do not keep so well. Under ordinary circumstances 60° appears to be the best heat at which to start fermentation, or, in the case of strong ale, 58°.

Fermentation.—The fermenting tun may be round or square, open or closed, and made of wood or stone. Stone squares are universal in the northern counties of England, but are rarely met with in the southern and midland counties. When beer is fermented in a stone or slate square, it should never be pitched at a lower heat than 66° or 68°; for these utensils are very cold, and therefore liable to check or stop the fermentation. Every fermenting tun should be fitted with an attemperator. The attemperator consists of a series of pipes fixed within the tun, and having its inlet and outlet on the outside. It should be possible to run hot or cold water through these pipes at any hour, so that the temperature of the gyle can be raised or lowered at pleasure. The work performed by that natural process which we call fermentation is the conversion of saccharine matter into alcohol. It plays a most important part in the brewer's art, and deserves his most careful attention. In order to obtain a quick and regular fermentation, the brewer employs yeast, or barm, as it is called in some parts of the country. Great care must be taken that the yeast used shall be perfectly fresh and healthy, for it must never be forgotten, that it is impossible to obtain a good fermentation from bad yeast. Yeast that comes from porter should never be used in pale or delicately flavoured ales, as it is apt to impart a burnt taste and high colour. The quantity of yeast required depends upon the strength of the wort and the quality of the water. Strong worts require more yeast than weak ones; and the same rule applies to hard waters as compared with soft. Worts of about 20 ℔ gravity should do well with 1 ℔ of yeast per barrel, whilst stronger worts require twice that quantity. As we have said, 60° seems to be the best heat at which to pitch wort, unless it is of a high gravity, or the fermenting tun be built in a very warm place, in which case the temperature of 58° will not be too low.

The appearance of a gyle of beer during the earlier stages of a good fermentation is very beautiful. At first the whole surface is covered with a thick white foam, which, within a few hours, curls itself into every imaginable shape and form. This increases in height, until it presents the appearance of a number of jagged rocks of snowy whiteness. With these the artistic beauties of the fermentation disappear, although the fine thick head of yeast which follows delights the eye of the practised brewer, for it tells him that his fermentation is drawing towards a successful end. But the progress of the fermentation must not be judged by appearances alone. Samples should be taken from the tun at least twice a day, and weighed with the saccharometer. By this means the brewer tells at what speed the sugar is being converted into alcohol; and when he considers the process has gone far enough, he stops it by taking away the yeast, which operation is termed cleansing. At the end of the first twenty-four hours, the gyle should attenuate 1 ℔ in every three or four hours, whilst the temperature should rise from 1° to 2° during the same space of time. The fermentation may proceed quicker than this without any harm ensuing; but if it does not reach the *minimum* speed of 1 ℔ in four hours, it may be said to be sluggish, and requires assisting. This is done by "rousing" the gyle every two hours with a utensil made for the purpose. Wort fermented in stone or slate squares must be roused every hour and a half, without exception. If unchecked the temperature of the gyle will rise to 76° or even 80°. Any heat above 72° is likely to affect the beer injuriously, for at that temperature the acetous fermentation commences. At the same time, beers for quick consumption may be allowed to rise a few degrees higher, and will perhaps be improved by the increase of temperature. The attemperator must be used to prevent the gyle reaching too high a heat.

Cleansing is the act of removing the yeast from the beer, in order to stop the fermentation. There are three modes of cleansing—*1st*, by simply skimming the yeast off as it rises to the surface; *2d*, by running the beer into casks, and then allowing the yeast to work out through the bung holes; and *3d*, on what is called the Union, or Burton system, which is the second plan with some improvements. When beer is cleansed in the second or third mode, it is necessary to keep the casks or Unions full to the bung. They must, therefore, be refilled every two hours, either by hand or by a self-acting apparatus invented for the purpose. Brewers differ as to the time when the operation of cleansing should commence; and, indeed, it is difficult to fix any limit, as much depends upon the character of the ale and the appearance of the fermentation. In the writer's opinion strong ales, worked in casks or on the Burton system, should be cleansed when they have attenuated down to 12 or 14 ℔; weaker beers and pale ales should be allowed to go quite 2 ℔ lower before being cleansed. Stout and porter should be cleansed rather earlier than any kind of ale, in order that they may drink full in the month. When all the yeast has worked out of the beer, it is ready for the last process.

Racking and Storing.—Ales intended for quick consumption should be racked so soon as clean, or they will be found flat and out of condition. A few of the finest hops should be put into the cask; and in the case of pale ale the quantity should not be less than 1 ℔ to the barrel. The finest strong and India pale ale should be stored between two and three months before being tapped, and even at that age, must be considered young. Ales intended to be stored some months should have a porous vent peg placed in the shive to keep the ale from fretting, and save the head of the cask from being blown out. (S. A. W.)

BREWSTER, Sir David, natural philosopher, distinguished especially for his original discoveries in the science of optics and his numerous and varied contributions to scientific literature, was born on the 11th December 1781 at Jedburgh, where his father, a teacher of high reputation, was rector of the grammar school. At the early age of twelve he was sent to the University of Edinburgh, being intended for the clerical profession. Even before this, however, he had shown a strong inclination for physical inquiries, which had been fostered by his intimacy with a "self-taught philosopher, astronomer, and mathematician," as Sir Walter Scott called him, of great local fame—James Veitch of Inchbonny. Veitch was particularly skilful in making telescopes, and may thus have had some influence in determining the precise direction of his young companion's future researches. Though he duly finished his theological course and was licensed to preach, Brewster's natural preference for other pursuits, combined with a constitutional nervousness, prevented him from engaging in the active duties of his profession. In 1799 he was induced by his fellow-student, Brougham, to study the inflection of light, repeating Newton's experiments; and from this date he carried on, almost without interruption, the course of original discovery in the science of physical optics which constitutes one of his chief claims to distinction. The results of his investigations were communicated from time to time in papers to the *Philosophical Transactions* of London and other scientific journals, and were admirably and impartially summarized by Professor James D. Forbes in his preliminary dissertation to the eighth edition of this Encyclopædia. The fact that other philosophers, notably Malus and Fresnel, were pursuing the same investigations contemporaneously in France does not invalidate Brewster's claim to independent discovery, even though in one or two cases the priority must be assigned to others.

The most important subjects of his inquiries are enumerated by Forbes under the following five heads:—1. The laws of polarization by reflection and refraction, and other quantitative laws of phenomena; 2. The discovery of the polarizing structure induced by heat and pressure; 3. The discovery of crystals with two axes of double refraction, and many of the laws of their phenomena, including the connection of optical structure and crystalline forms; 4. The laws of metallic reflection; 5. Experiments on the absorption of light. In this line of investigation the prime importance belongs to the discovery (1) of the connection between the refractive index and the polarizing angle, (2) of biaxal crystals, and (3) of the production of double refraction by irregular heating. These discoveries were promptly acknowledged by those best qualified to estimate their value. So early as the year 1807 the degree of LL.D. was conferred upon Brewster by Marischal College, Aberdeen; in 1815 he was made a member of the Royal Society of London, and received the Copley medal; in 1818 he received the Rumford medal of the Society; and in 1816 the French Institute awarded him one-half of the prize of three thousand francs for the two most important discoveries in physical science made in Europe during the two preceding years. Among the non-scientific public his fame was spread more effectually by the invention, in 1816, of the elegant philosophical toy, the kaleidoscope, for which there was so great a demand both in England and America that for some time the supply could not meet it. An instrument of higher interest, the stereoscope, which, though of much later date (1849–50), may be mentioned here, since along with the kaleidoscope it did more than anything else to popularize his name, was not, as has often been asserted, the invention of Brewster. Wheatstone discovered its principle and applied it as early as 1838 to the construction of a cumbrous but effective instrument, in which the binocular pictures were made to combine by means of mirrors. To Brewster is due the merit of suggesting the use of lenses for the purpose of uniting the dissimilar pictures; and, accordingly, the lenticular stereoscope, now in exclusive use, may fairly be said to be his invention. A much more valuable practical result of Brewster's optical researches may be traced in the vast improvement of the lighthouse system during the last half century. It is true that the dioptric apparatus was perfected independently by Fresnel, who had also the satisfaction of being the first to put it into operation, the French Government being in this, as in many other cases, quicker than the English to perceive the value of new scientific discoveries. But it is indisputable that Brewster was earlier in the field than Fresnel; that he described the dioptric apparatus in 1812; that he pressed its adoption on those in authority at least as early as 1820, two years before Fresnel suggested it; and that it was finally introduced into British lighthouses mainly by his persistent efforts. The tribute paid to his memory by his successor at the head of the University of Edinburgh was therefore as just as it was graceful:—"Every lighthouse that burns round the shores of the British empire is a shining witness to the usefulness of Brewster's life."

Brewster's own discoveries, important though they were, were not his only, perhaps not even his chief, service to science. The extent and variety of his contributions to scientific literature were little short of marvellous. He commenced literary work in 1799 as a regular contributor to the *Edinburgh Magazine*, of which he acted as editor at the age of twenty. In 1807 he entered on a much larger undertaking, which cost him long continued labour, and, especially towards its close, great vexation and anxiety. The chance suggestion of a friend, who knew his varied powers, led to the projection, under his editorship, of the *Edinburgh Encyclopædia*, of which the first part appeared in 1808, and the last not until 1830. The work was, as might have been expected, strongest in the scientific department, and many of its most valuable articles were from the pen of its editor. At a later period he was one of the leading scientific contributors to the *Encyclopædia Britannica* (seventh and eighth editions), the articles Electricity, Hydrodynamics, Magnetism, Microscope, Optics, Stereoscope, Voltaic Electricity, &c., being from his pen. In 1819 Brewster undertook further editorial work by establishing, in conjunction with Jameson, the *Edinburgh Philosophical Journal*, which took the place of the *Edinburgh Magazine*. After a time the title was again changed to the *Edinburgh Journal of Science*, sixteen volumes of which appeared under Brewster's sole editorship, with very many articles from his own pen. To the transactions of various learned societies he contributed from first to last between three and four hundred papers, and few of his contemporaries wrote so much for the various reviews. In the *North British Review* alone seventy-five articles of his appeared. A list of his larger separate works will be found below. Special mention, however, must be made of the most important of them all—his biography of Newton. In 1831 he published a short popular account of the philosopher's life in Murray's *Family Library*; but it was not until 1855 that he was able to issue the much fuller *Memoirs of the Life, Writings, and Discoveries of Sir Isaac Newton*, a work which embodied the results of more than twenty years' patient investigation of original manuscripts and all other available sources.

Brewster's relations as editor brought him into frequent communication with the most eminent scientific men, and he was naturally among the first to recognize the benefit

that would accrue from regular intercourse among labourers in the field of science. In an article in the *Quarterly Review* he threw out a suggestion for "an association of our nobility, clergy, gentry, and philosophers," which was taken up by others and found speedy realization in the British Association for the Advancement of Science. Its first meeting was held at York in 1831; and Brewster, along with Babbage and Herschel, had the chief part in shaping its constitution. It was this service mainly that was referred to when it was said of him after his death that "the improved position of men of science in our times is chiefly due to Sir David Brewster." In the same year in which the British Association held its first meeting Brewster received the honour of knighthood and the decoration of the Guelphic order of Hanover. In 1838 he was appointed principal of the united colleges of St Salvator and St Leonard, St Andrews. Two of the highest honours of the scientific world were conferred upon him in 1849, when he filled the office of president of the British Association and was elected one of the eight foreign associates of the Institute of France in succession to Berzelius. In 1859 he accepted the office of principal of the University of Edinburgh, the duties of which he continued to discharge vigorously until within a few months of his death, which took place at Allerly, Melrose, on the 10th February 1868.

In estimating Brewster's place among scientific discoverers the chief thing to be borne in mind is that the bent of his genius was not characteristically mathematical. His method was empirical; he was a painstaking and accurate observer and classifier of facts rather than a theorizer; and the laws which he established, some of them, as has been pointed out, of prime importance, were generally the result of repeated experiment. To the ultimate explanation of the phenomena with which he dealt he contributed nothing, and it is noteworthy in this connection, that if he did not maintain to the end of his life the corpuscular theory he never explicitly adopted the undulatory theory of light These limitations, however, are to be taken as characterizing his genius rather than as detracting from it. Few will be inclined to dispute the verdict of Forbes:—"His scientific glory is different in kind from that of Young and Fresnel; but the discoverer of the law of polarization, of biaxal crystals, of optical mineralogy, and of double refraction by compression, will always occupy a foremost rank in the intellectual history of the age." In addition to the various works of Brewster already noticed the following may be mentioned:—Notes and Introduction to Carlyle's translation of Legendre's *Elements of Geometry* (1824); *Treatise on Optics* (1831); *Letters on Natural Magic*, addressed to Sir Walter Scott (1831); *The Martyrs of Science, or the Lives of Galileo, Tycho Brahe, and Kepler* (1841); *More Worlds than One* (1854). (See *The Home Life of Sir David Brewster*, by his daughter Mrs Gordon.)

BRIANÇON, a very strongly fortified town of France, the capital of an arrondissement in the department of Hautes-Alpes, situated on a hill about 4300 feet above the level of the sea, near the source of the Durance, in lat. 44° 53′ N. and 6° 47′ E. long. It commands the road across Mount Genèvre between France and Italy, and is well defended by its natural position; while the surrounding eminences are crowned with strong fortifications communicating with each other and the town by subterranean passages. The town itself is one of the highest in Europe, and the neighbouring village of St Veran has the loftiest situation of any in France. The principal buildings in Briançon are a church in the Italian style, the departmental prison, and a communal college. A single-arch bridge, 127 feet in span and 180 feet high, crosses the valley of the Clarée, affording access from the town to the principal parts of the fortifications. There is an extensive silk-factory in the old convent of St Catherine, which manufactures floss silk, stockings, hats, and other silk goods; and the other industrial articles in the town comprise small iron wares, leather, and lavender water. A considerable traffic is carried on in chalk, and in turpentine and other forest productions. The chalk, though known as Briançon chalk, is obtained at Fenestrelles in Piedmont; the Briançon manna is a kind of resin. Briançon is identified with *Brigantium*, a city of great antiquity and dubious origin, which became an important military post under the Romans. For a long time after the fall of the Roman empire it maintained itself as an independent republic, and was not united to France till 1349. Made over by the peace of Ryswick to the duke of Savoy, it was restored to France in 1713. In 1815 the town made a noble defence. Population in 1872, 3579.

BRIANSK, a town of Russia, in the government of Orloff, 98 miles E.N.E. of the city of that name, in 53° 15′ N. lat., and 22° 50′ E. long., on both banks of the Desna, opposite the mouth of the River Snezheta. It is divided into four parts by several smaller streams. The town is mentioned in 1146, and then bore the names of Briansk and Debriansk. It afterwards formed a separate principality, which came to an end in 1356 with the death of Prince Basil Alexandrovitch. After the Mongolian invasion Briansk and the whole Siever country fell under the power of the Lithuanians; but from time to time it was united with Russia, and finally became incorporated with the empire in the beginning of the 17th century in the reign of Michael Theodorovitch. Under the first Demetrius Briansk was taken by the rebels, but successfully resisted the attacks of the second impostor. Under the Empress Anna, according to the plan of Paul I., there was constructed a dock for the building of ships, but it was closed in 1739. In 1778 the town was made the capital of a department in Orloff, and in 1783 an arsenal, which still exists, was established for the manufacture of artillery. Briansk has thirteen churches, of which the cathedral was built in 1526, and restored in the end of the 17th century. In the sacristy is preserved a manuscript copy of the gospels in the writing of Michael Theodorovitch, which dates from 1637. In the convent of Peter and Paul is buried Oleg Romanovitch, prince of Chernigoff and Briansk, who lived in the 13th century. There are two high schools in the town, a hospital, and a dispensary; and the industrial establishments include rope-walks, tobacco-factories, brick-works, tallow-boiling works, flour-mills, and a brewery. A considerable trade is carried on, especially in wood, pitch, linseed-oil, and cattle, which are exported to Moscow and St Petersburg. There are markets twice a week, and one annual fair. In 1860 the population was 12,816, all of the Greek Church except 268 Catholics and 35 Jews. In 1867 it amounted to 13,881.

BRIAREUS, or ÆGÆON, one of the three hundred-armed (*Hekatoncheires*) sons of Uranus and Gaia,—his brothers being named Cottus and Gyges. The legends regarding them are various and somewhat contradictory. According to the most widely-spread myth, Briareus and his brothers were called by Zeus to his assistance when the Titans were making war upon Olympus. The gigantic enemies were defeated and consigned to Tartarus, at the gates of which the three brothers were placed. Other accounts make Briareus one of the assailants of Olympus, who, after his defeat, was buried under Mount Ætna. Homer mentions him as assisting Jupiter when the other Olympian deities were plotting against the king of gods and men. It would be difficult to determine exactly what natural phenomena are symbolized by the Hekatoncheires. They may represent the gigantic forces of nature which appear in earthquakes and other convulsions, or the multitudinous motion of the

sea waves. The latter interpretation is rendered more probable by the fact that Briareus is frequently called a marine deity, and is sometimes said to have been a son of Pontus and Gaia.

BRIBERY, as a public offence, may be defined as the administration of a bribe or reward, that it may be a motive in the performance of functions for which the proper motive ought to be a conscientious sense of duty. When this is superseded by the sordid impulses created by the bribe, a person is said to be corrupted, and thus corruption is a term sometimes held equivalent to bribery. The offence may be divided into two great classes,—the one characteristic of despotisms, where a person invested with power is induced by payment to use it unjustly; the other, which is an unfortunate characteristic of constitutional governments, where power is obtained by purchasing the suffrages of those who can impart it. The former offence is in every sense the more odious and formidable, and indeed it may be said, that until a country has outgrown it, there is no room for the existence of elective bribery, since the nations among which justice is habitually sold appear to be far below the capacity of possessing constitutional rights.

When Samuel in his old age challenges a rigid scrutiny of his conduct, he says, "Whose ox have I taken, or whose ass have I taken? or whom have I defrauded? whom have I oppressed? or of whose hands have I received any bribe to blind mine eyes therewith." And Amos, when denouncing the condition of the Israelites under Jeroboam, says, "They afflict the just, they take a bribe, and they turn aside the poor in the gate from their right." It is a natural propensity, removable only by civilization or some powerful counteracting influence, to feel that every element of power is to be employed as much as possible for the owner's own behoof, and that its benefits should be conferred not on those who best deserve them, but on those who will pay most for them. Hence judicial corruption is an inveterate vice of imperfect civilization. It is so deeply seated among Oriental races, that the attempts by controlling authority to eradicate it have been often futile. It has been the main impediment to the employment of natives in the British Eastern empire, since no external appearance of respectability, or apparent systematic routine of business, can be relied on as securities that the whole organization is not contaminated by systematic bribery. It is difficult to get the Oriental mind to understand how it is reasonable to expect the temptation of a bribe to be resisted. In the Russian empire this Oriental characteristic has had another conflict with the demands of a higher civilization. The organization of the Government requires that the empire should be honestly served by its official men, but their morality is of the humblest Oriental standard, and force will not change it. In no country, perhaps, has the offence been visited with more dire chastisement where it has been discovered, yet by the concurring testimony of all who are acquainted with Russian society, not only the official departments, but the courts of law are still influenced by systematic bribery. There is, perhaps, no other crime on which the force of law, if unaided by public opinion and morals, can have so little influence; for in other crimes, such as violence or fraud, there is generally some person immediately injured by the act, who can give his aid in the detection of the offender, but in the perpetration of the offence of bribery all the immediate parties obtain what they desire, and are satisfied.

The purification of the bench from judicial bribery has been gradual in most of the European countries. In France it received an impulse in the 16th century from the high-minded chancellor L'Hôpital. In England judicial corruption acquired a painful, but perhaps a wholesome renown, from the fate of the illustrious Bacon. In Scotland for some years after the Revolution the bench was not without a suspicion of interested partiality; but during the present century, at least, there has been in all parts of the empire a perfect reliance on its purity. The same may be said of the higher class of ministerial officers. There is no doubt that in the period from the Revolution to the end of Queen Anne's reign, when a speaker of the House of Commons was expelled for bribery, and the great Marlborough could not clear his character from pecuniary dishonesty, there was much corruption in the highest official quarters. The level of the offence of official bribery has gradually descended, until it has become an extremely rare thing for the humbler officers connected with the revenue to be charged with it. It has had a more lingering existence with those who, because their power is more of a constitutional than an official character, have been deemed less responsible to the public. During Walpole's administration there is no doubt that members of Parliament were paid in cash for votes; and the memorable saying, that every man has his price, has been preserved as a characteristic indication of his method of government.

One of the forms in which administrative corruption is most difficult of eradication is the appointment to office. It is sometimes maintained that the purity which characterizes the administration of justice is here unattainable, because in giving a judgment there is but one form in which it can be justly given, but when an office has to be filled many people may be equally fitted for it, and personal motives must influence a choice. It very rarely happens, however, that direct bribery is supposed to influence such appointments.

It does not appear that bribery was conspicuous in England until, in the early part of the 18th century, constituencies had thrown off the feudal dependence which lingered among them; and, indeed, it is often said, that bribery is essentially the defect of a free people, since it is the sale of that which is taken from others without payment. It is alluded to by Fielding and Smollett, and had become conspicuous in the days of Hogarth, who represents it in its double shape of demoralization; one picture shows a reckless expenditure of money among profligate expectants, whose demoralization is a systematic source of profit to them, while another presents us with the impoverished father of a family urged against his conscience to relieve the misery of his wife and children by the sale of his vote.

In England electoral bribery has been the subject of much legislation, which culminated in the Corrupt Practices Prevention Act of 1854 (17 and 18 Vict. c. 102). By this Act the following persons shall be deemed guilty of bribery, and shall be punishable accordingly:—

1. Every person who shall directly or indirectly, by himself or by any other person on his behalf, give, lend, &c., or offer, promise, or promise to procure, &c., any money or valuable consideration to or for any voter or any other person in order to induce any voter to vote or refrain from voting, or shall corruptly do any such act on account of such voter having voted or refrained from voting at any election.

2. Every person who shall similarly give or procure or promise, &c., any office, place, or employment to or for any voter or other person in order to induce him to vote, &c.

3. Every person who shall make any gift, loan, promise, &c., as aforesaid to any person to induce such person to procure the return of any person to serve in Parliament or the vote of any voter.

4. Every person who shall, in consequence of such gift, procure or engage, promise or endeavour to procure the return of any person or the vote of any voter.

5. Every person who shall pay any money with the

intent that it should be spent in bribery, or who shall pay money in repayment of any money wholly or in part expended in bribery.

Persons so offending are guilty of a misdemeanour (in Scotland, of an offence punishable by fine and imprisonment), and shall be liable to forfeit the sum of £100 to any person who will sue for the same, together with costs. Sect. 3 extends the offence (1) to persons who before or during an election shall receive or contract for any money, &c., for voting, or refraining, or agreeing to vote or to refrain from voting; and (2) to persons who, after the election, receive money, &c., on account of any person having voted or refrained, &c. Such persons shall be guilty of a misdemeanour and forfeit £10.

Treating is defined in Sect. 4. Every candidate who gives, procures, or pays for any expenses incurred for meat, drink, or entertainment, or provision to or for any person in order to be elected, or for being elected, or for the purpose of corruptly influencing such person to give or refrain from giving his vote at an election, &c., shall be deemed guilty of treating, and forfeit £50 to any person who shall sue for the same; and every person corruptly accepting such meat, drink, &c., shall be incapable of voting at such election. Persons found guilty of bribery, &c., or from whom penalties as above mentioned have been recovered, shall be struck off the list of voters by the revising barrister. Prosecutions and actions under the Act must be begun within one year. Other sections of the Act prohibit giving cockades to voters at elections, or supplying them with refreshments on account of their having polled or being about to poll. Any candidate for a county, city, or borough found guilty by an election committee of bribery, treating, or undue influence by himself or his agents shall be incapable of being elected or sitting in Parliament for such county, city, or borough, during the Parliament then in existence. Up to 1868 disputed elections were dealt with by committees of the House of Commons, but the Parliamentary Elections Act (31 and 32 Vict. c. 125) has transferred the jurisdiction to Her Majesty's judges (see ELECTIONS). The report of the judge is to have the same effect as the report of an election committee under the old law; and if he reports that corrupt practices have extensively prevailed, a commission of inquiry may be issued under 15 and 16 Vict. c. 57. Candidates reputed by the judge to be guilty of bribery shall be incapable of being elected to the House of Commons for seven years, and during the same period may not (1) be registered as voters; or (2) hold office under 5 and 6 Will. IV. c. 76, or 3 and 4 Vict. c. 108, or any municipal office; or (3) hold any judicial office, or act as justice of the peace. Other persons found guilty of bribery after having had an opportunity of being heard suffer the same disqualifications. Similar provisions against bribery, &c., at municipal elections are contained in the Act 35 and 36 Vict. c. 60.

If the election commissioners, appointed under 15 and 16 Vict. c. 57, report the extensive prevalence of corrupt practices, bills may be brought in for the disfranchisement of the constituency. Bridgewater, Beverley, Sligo, and Cashel were so disfranchised in 1870. Four boroughs—Totnes, Reigate, Great Yarmouth, and Lancaster—were disfranchised by the Representation of the People Act, 1867, for corrupt practices. In the case of a vacancy in a constituency where corrupt practices have prevailed at last election, the House may disfranchise it indefinitely, either by a resolution to that effect or by negativing the motion for a new writ.

The judges manifested great repugnance to the new jurisdiction conferred on them by the Elections Act, and vigorously remonstrated against it during the passage of the measure through Parliament. It was feared that the purity of the bench might be sullied by being brought into close connection with political contests. Public opinion, however, had distinctly condemned the House of Commons Election Committees, which where necessarily anything but judicial in character, and were, besides, tainted with the suspicion of being frequently actuated by political motives. Many petitions have now been tried by the judges, and in a manner which has given great satisfaction to the country. One consequence of the new system which might have been anticipated is the introduction of more precise definitions into the phraseology of election law. "Agency," for example, and "valuable consideration," have been treated by the judges according to the ordinary meaning of the words in courts of law, and candidates have been unseated for the acts of persons, technically their "agents," but personally unknown to them, and for gifts, generally reputed laudable, but legally falling within the definition of bribes. Bribery flourishes most vigorously in the English borough constituencies; and the secret voting introduced by the Ballot Act seems to have had very little effect on the practice, on account of the fidelity with which the corrupt voters keep their promises. In a recent election inquiry before commissioners, witnesses declared their belief that a quarter, or even more, of the constituency was permanently corrupt, and held the balance between the two political parties. Extensive bribery under the guise of charitable distributions of coal, provisions, &c., seems to prevail in many constituencies, and a still more indirect form is the payment of large subscriptions to public purposes. Recently, it has been observed, constituencies have shown a marked preference for wealthy candidates with some local connection.

BRICK, a kind of artificial stone made of baked clay. The usual form of a brick is a parallelopipedon, about 9 inches long, 4½ inches broad, and 3 inches thick. The art of brickmaking dates from very early times. We read that burnt brick was used in building the tower of Babel. The walls and various other buildings of ancient Babylon were made of burnt brick; several varieties of brick figure in Assyrian art, and most of the Assyrian literature was in the form of minute characters in baked clay (see BABYLON, BABYLONIA). Brickmaking formed the chief occupation of the Israelites during their degrading bondage in Egypt. The bricks were made of clay mixed with chopped straw, and were probably sun dried. We read (2 Sam. xii. 31) that David made the children of Ammon pass through the brick kiln; and while the meaning of the statement is doubtful, it is thought that the instruments mentioned in the context may have been used in preparation of the clay. Pliny informs us of three different kinds of bricks made by the Greeks. In Italy we have abundant evidence that the Romans used bricks largely; and it was they, probably, who introduced brickmaking into England. By the time of Henry VIII. the art had reached great perfection; and many fine brick buildings (*e.g.*, the older part of Hampton Court) are extant from that period. Previous to the great fire of 1666, many of the London houses consisted chiefly of timber framework, filled in with lath and plaster; but after the fire, brick was used almost exclusively in building. Much of the brickwork remaining from that time is finely

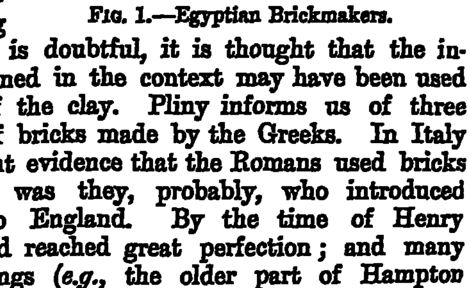


FIG. 1.—Egyptian Brickmakers.

carved with the chisel. From the latter part of last century (1784) till 1850, bricks in this country were subject to taxation. In Holland, where stone is scarce, bricks have been in use from a very early period, both for domestic and public buildings.

c- is The quality of bricks depends primarily on the choice of an earth. There are three principal classes of brick-earths:—(1.) Pure clays, consisting chiefly of alumina and silica, in various proportions, and with a small percentage of other salts, iron, lime, magnesia, &c.; (2.) Loams or sandy clays; (3.) Marls, or earths with a considerable proportion of lime. A paste of pure clay alone (made with water), while it may be easily moulded, will shrink and crack in drying and firing, in proportion to the excess of alumina over silica; but this can be remedied by mixture with a milder earth or with sand. Loams, again, are often so loose that they require the addition of lime as a flux. The London brickmakers add lime and ashes, or *breeze*, to their loams and marls, both as a flux and to prevent shrinking; such admixtures also, as will be seen, affect colour. Brick-earths are very various in composition. The proportion of ingredients in a good earth will be something like the following:—silica, three-fifths; alumina, one-fifth; iron, lime, magnesia, manganese, soda, and potash forming the other one-fifth. The clays of which fire-bricks for furnaces are made are almost entirely free from lime, magnesia, and like substances, which act as fluxes; they are found throughout the coal measures, immediately beneath the coal. The best, that of Stourbridge, will bear the most intense heat that can be produced, without fusion. The Welsh fire-bricks, and those of Windsor, Newcastle, and Glasgow, are other well-known varieties. The Dinas fire-brick consists almost entirely of silica; to this is added about one per cent. of lime, and the mixture, after moulding, is intensely heated. In Austria, a very refractory siliceous brick is manufactured by M. Khern, the chief ingredient being quartz of the highest possible degree of purity.

The colour of bricks is determined by the proportion of hydrated oxide of iron and other ingredients they contain, also by the degree of heat in burning. Where iron is present without lime or such substances, a moderate red heat makes the bricks red, the intensity varying with the proportion of iron; with more intense heat, the bricks, if slightly fusible, may be vitrified externally, and become greenish blue (*e.g.*, the blue bricks of Staffordshire). The presence of lime changes the red colour produced by iron to a cream brown, magnesia also arrests the development of red. Clays burning a pale red will burn yellow if mixed with a fusible white sand, such as is often found on heaths. Some clays, as those of Devonshire and Dorsetshire, burn of a clear white. The London malms give a rich brimstone yellow. The art of ornamental polychrome brick-work has of late years been much developed, especially by the German architects. The principal varieties of common bricks made in England are *place bricks*, *grey and red stocks*, *marl facing bricks*, and *cutting bricks*. The first two are used in ordinary walling. The marl facing bricks, made in the neighbourhood of London, are superior to the stocks, and used in the outsides of buildings. Cutting bricks, which are the finest kind of marl and red bricks, are used in arches over windows and doors.

ick-king. The process of brickmaking varies considerably in different localities. In the following account we shall, in the first instance, confine our attention to methods adopted in the vicinity of London, and thereafter note some of the peculiarities of other systems. The most common mode of preparing the clay, in the London district, is that of *malming*. Among the varieties of brick-earth found there *malm* is a substance that can be used for bricks without any addition. But it is now rare, and an artificial malm is made by mixing chalk and clay, previously reduced to pulp, and allowing the mixture to consolidate by evaporation. Bricks of the best quality are made with this alone; but for the commoner sorts some of the malm is added to the clay or loam, sufficient to make it fit for brick-making.

The earth is dug up in autumn, and placed on a level floor, banked round in order to retain the malm in the process of malming. Exposed during the winter, it is more or less broken up and pulverized by the frost, &c. The machinery for malming consists of two washing-mills, viz., the chalk and clay mills, which are placed together, not far from the brick-earth. The chalk-mill is a circular trough in which chalk is ground in water, by two heavy wheels with spiked tires, drawn round by horses. The pulp thus made passes by a shoot into the clay-mill, another and a larger circular trough, where it gets mixed with clay that is being cut and stirred in water by knives and harrows, also put in motion by horses. The creamy liquid malm passes through a grating into shoots which convey it to the brick-earth, over which it is distributed as equally as possible. It is now left to settle for a month or more, the water being drained off at intervals, till the mass is firm enough to bear a man walking over it. A thin layer of ashes, about 3 inches for every spit of earth, is spread over the surface (this process being technically called *soiling*), and the whole is now ready for the moulding season, which commences generally in April. Malming

The mass of earth, malm, and ashes is first *tempered*, or thoroughly turned over and mixed with the spade, while water is added to give it the proper consistence. The tempered clay is then conveyed to the *pug-mill*,—a conical tub, in which revolves (driven by horses) a vertical shaft with horizontal knives so inclined that the clay is slowly forced down to the narrow end by their motion. Several of these knife-arms are furnished with cross knives, which assist in the cutting and kneading process. The clay comes out laterally at the bottom as a uniform mass, and is ready for moulding.

The moulder stands at a table or stool, on which are placed some of the tempered clay in front of him, a little dry sand to the right and left, a small tub of water with the *strike* in it, a brick-mould, and a stock-board. Backwards from the stool extends the *page*, a pair of iron rails, on wood, on which the raw bricks are pushed away by the moulder. The *brick-mould* is a rectangular case of sheet-iron, without top or bottom, having the two longer sides strengthened with wood. The *stock-board*, supported on four pins in the moulder's stool, fits easily into the mould; it has often a solid elevation in the middle, for producing a hollow in the brick. The moulder receives from the clot-moulder (usually a woman), standing on his right, a piece of clay somewhat larger than a brick. Having sprinkled sand on the stock-board, and dashed the mould, after moistening it, in the left sand heap, he places the mould on the stock-board, and dashes the clay into it with force, then pressing it with his fingers so as to fill the angles. With the *strike* (a short, smooth piece of wood) he strikes off the surplus clay; then he turns the brick out of the mould on a thin board or *pallet*, rather larger than the brick, and slides it along the page to the taking-off boy, who stands ready to put the bricks on a barrow of special construction; on this, after sprinkling with sand, they are conveyed to the hack ground. The bricks are each carefully removed from the barrow between two pallets, and built up in *hacks*, about eight bricks high, and two in width (placed edgewise, and in an angular direction,—the hacks being about 11 feet apart, from centre to centre. They are covered with straw or reeds at night or in bad weather. When half dry the bricks are separated somewhat (*scintled*), to allow Moulding

free access of the air. The time taken in drying varies from three to six weeks.

rning. In the vicinity of London bricks are commonly burnt in *clamps;* the peculiarity of which process is that, as each brick contains in itself the fuel necessary for its vitrification, the *breeze* merely serves to ignite the lower tiers, and the heat gradually spreads over the whole. The general structure of a clamp is as follows :—A number of walls, or *necks*, three bricks thick, about sixty long, and twenty-four to thirty high, are built slantingly against a central upright wall, which narrows upwards. The sides and top are cased with burnt bricks. Cinders (or *breeze*) are distributed in layers between the courses of brick, the thickest strata being at the bottom. A single clamp will contain from 200,000 to 500,000 bricks. For firing the clamps, *live holes* or flues (9 inches by 7) are left in the centre of the upright, and at every seventh neck or so, extending throughout the thickness of the clamp. These are filled with faggots, and fired by a coal fire at the end of each vent; and the fire ignites the adjacent breeze. Once the clamp is fairly lighted, the mouths of the live holes are stopped with bricks and plastered over with clay, and the clamp burns till all the breeze is consumed, usually from three to six weeks. After cooling, the bricks are removed, sorted, perhaps, and stacked. (For a fuller account of the most approved methods of building clamps, the reader is referred to Mr Dobson's excellent little treatise on brick-making, to which we are indebted for many of the details given in this paper.)

ttingham. In the Nottingham district a very hard marl is often used in brickmaking; and as ordinary weathering and tempering would not make it sufficiently plastic, it is subjected to grinding between rollers, the hard lumps and pieces of limestone being thus crushed to powder, all pebbles and hard stones having been previously picked out by the hand. The wash-mill is only used in making arch-bricks, and the pug-mill is dispensed with, the tempering of the clay, after grinding, being done by treading and spade labour. Sometimes the clay is kept in damp cellars for a year or more to ripen. Brass moulds (technically called copper moulds) are used, and the moulder, after filling the mould, works over the clay, first on one side then on the other, with a flat implement called the *plane*. A boy takes the mould with its contents to the floor, where he turns out the brick, and then puts back the mould on the stool, the moulder meanwhile filling another mould. The bricks are sprinkled with sand on the floors, and turned twice at a few hours' interval, and are then taken by boys to the *hovel* or drying-shed, when they are built in hacks. They are burnt in kilns, which are made with four upright walls and a sunken floor. On the two sides of the kiln there are shallow pits with lean-to roofs to protect the fuel and fireman. The doorways are narrow openings at the ends, a step above the ground, and the fire-holes are arched openings opposite each other in the side of the kiln, lined with fire-bricks. Narrow openings or flues are left between the bricks, connecting the opposite fire-holes. Each brick has some free space round it for passage of heat. The fuel employed is coal.

tafford-hire. In the Staffordshire Potteries it is a common practice to pass the marl through several pairs of rollers, and then mix some three or four marls together, with water, by spade labour. For ordinary bricks the ground marl is mixed with marl that has been tempered but not ground. The pug-mill is employed for tiles and dust bricks,—the latter so called from coal dust being used when they are moulded. The bricks are moulded by the *slop-moulding* process, the mould being dipped in water only before using; the brick is emptied from the mould on the floor. (The other process is distinguished as that of *sand-stock moulding.*) The oven used in burning is of circular form, with spherical top, and will contain about 8000 bricks. Red, blue, and drab bricks are produced in the district, besides the dust brick just referred to, which is used for the paving of footways..

In Holland, the chief material used for bricks is the slime deposited in rivers and arms of the sea. It is collected in boats by men with long poles, having a cutting circle of iron at the end, and a bag net with which they lug up the slime. Hard bricks are made of a mixture of this slime with sand from the banks of the River Maas. The ingredients are well kneaded together, and the mixture is deposited in heaps. The mode of moulding and drying is similar to that used elsewhere. The kilns are square and will sometimes hold as many as 1,200,000 bricks. Peat turf is used in firing. Hollan

For an account of brickmaking in India the reader is referred to a paper by Major Falconnet, R.E., in the *Professional Papers on Indian Engineering*, May 1874.

Thus far only brickmaking by hand has been spoken of, but of recent years there has been no little activity in the invention of brickmaking machines, with a view to economy, certainty, and rapidity of production, and improvement in the quality and appearance of the bricks. It is only in brickmaking on a considerable scale, of course, that moulding by machinery can present much advantage over hand moulding, since the cost of moulding bears so small a proportion to the total cost. The various machines that have been offered to the public may be arranged in two classes,—those which operate on the clay (with moderate pressure) in a moist and plastic state, and those in which the material used is pulverized and dry, or nearly so. A denser brick, and one less liable to shrinking, is produced in the latter case; but much care is needed in preparation of the clay, and a much stronger compression is required, to ensure the proper tenacity. The different arrangements of rollers and pug-mills for *preparation* of the clay, whether plastic or dry, we need not here describe at any length. Rollers and pug-mill are sometimes combined, forming a composite machine. Two or more pairs of rollers are sometimes arranged one set under another, the closest at the bottom; and opposing rollers are driven at different speeds so as to produce a rub as well as a squeeze, thus promoting disintegration. As to that class of brickmaking machines proper in which plastic clay is used, we find, in some examples, a continuous length of clay forced out from a vertical or horizontal pug-mill through a suitable mouth-piece, and the column divided into bricks by wires or otherwise. Of mouthpieces, some are simple dies, or dies fitted with cores to make hollow bricks; in others the mould is lubricated by a constant stream of water; in others, again, the mouthpiece is made with two or four rollers covered with thick cloth, which are perforated with small holes, and filled with oil to lubricate the faces of the bricks. In cutting, a frame of parallel wires may be moved across, either while the clay is at rest, or while it is in motion, by the wires being moved obliquely at an angle to compensate for the speed at which the clay travels. Or the clay may be cut by radial wires of a wheel, or again by metallic discs. Another variety of treatment of plastic clay is that in which the clay is pressed from the pug-mill into moulds of the form of brick required. In one such machine, a mould-block, with two moulds, moves backwards and forwards under the pug-mill, one mould receiving a charge while the other is having the brick pressed out of it by a piston. In another, the moulds are arranged radially round the border of a circular table, which revolves under the pug-mill. There are piston rods in the mould which ascend an inclined spiral plane, and thus gradually lift the bricks out of the moulds, whence they are taken by a boy and placed on an endless band, which conveys them Brick-making machin

away. In another machine, also with revolving table, two moulds receive the charge of clay at once. While these are being filled the two that had just been filled are being subjected to considerable pressure, and the two bricks that had been pressed immediately before are in process of delivery out of the moulds, and on to a flat belt which takes them away. (This machine is also suitable for dry clay.) In yet another, a cylinder revolving under the pug-mill presents to it successively four brick-moulds, each of which, on reaching the lowest point, is made to deposit its brick on an endless band. The annexed drawing represents one of Messrs H. Clayton, Son, & Howlett's single delivery machines for brickmaking with plastic clay. After what has been said little description will be necessary. A is the pair of rollers, B the pug-mill, C the stream of issuing clay, which a little further on is cut across by

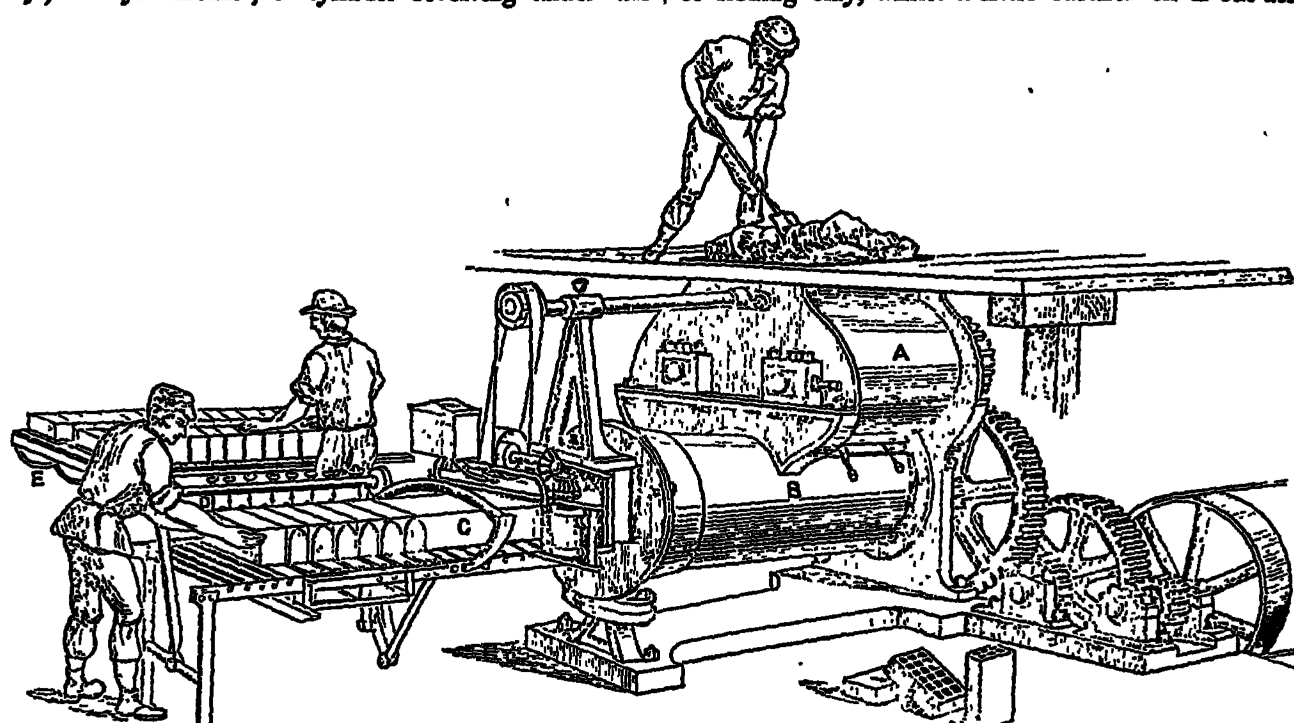


FIG. 2.—Brickmaking Machine for Plastic Clay.

means of the wire frame D. The bricks are then removed to the barrow E. These machines are often constructed for double delivery.

As an example of the second class of machines,—those for working dry, or half-dry, and non-plastic material,—we may take another machine constructed by Messrs Clayton. It affords a good practical solution of the problem of making bricks from coal shale, bind, fire-clay, or the like. The arrangement is shown in figs. 3 and 4. In fig. 3, A

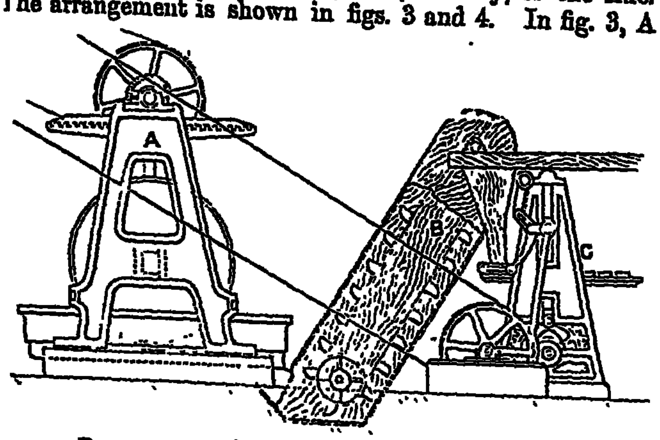


FIG. 3.—Section of Machine for Non-plastic Material.

is a pan roller mill, in which a pan containing the raw material is driven round under rollers; there are perforations in the bottom, through which the ground clay escapes, and is swept by arms into a general receiver, whence a band with buckets conveys it to the hopper of the moulding and pressing machines C, of which fig. 4 gives another view. Here the moulds are contained in a box at B, bolted between the standards. There are two sets of pistons, one above and the other below the brick-moulds, and they simultaneously press the top and the bottom of the brick in the mould. The lower pistons are attached to a cross bar which slides in vertical guides in the standards, and has friction rollers C on the lower extremities, in contact with which work two pressing cams D on the main shaft. The upper pistons E are attached as shown to a cross-head above, which is moved up and down in its guides by connecting rods and two cranks on the main

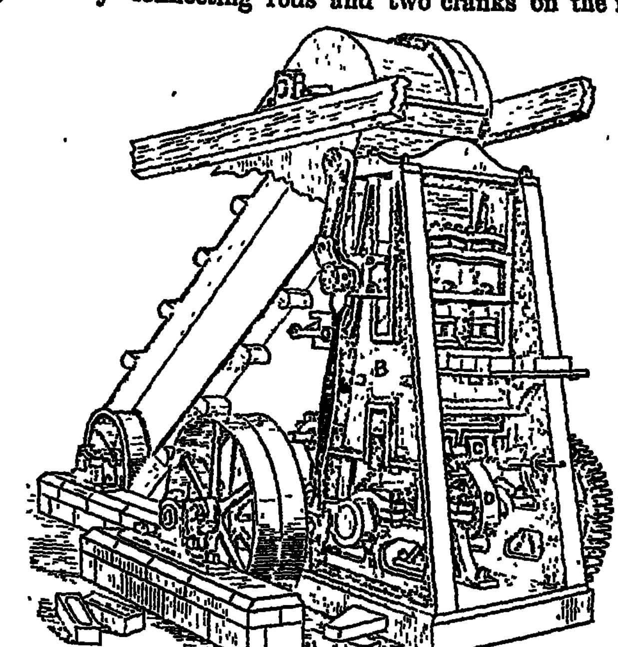


FIG. 4.—Part of Machine shown in section in fig. 3.

shaft. These pistons are hollow, and are heated by steam to prevent the brick-earth adhering to them. The prepared material is supplied to the two moulds by a feed-box which slides to and fro under the feeding hopper of the machine.

and thus passes alternately under it and over the moulds, conveying sufficient each time to fill the latter. The bricks are delivered from the moulds by the lower pistons, which are forced upwards by the complete revolution of the cams, and the newly-made bricks are forthwith moved forward by the approach of the feed-box with a fresh charge of the material. In another dry-clay machine constructed by Messrs Bradley and Craven of Wakefield, two or three distinct pressures can be given to a brick, and by this means the air is gradually forced out from the interstices, and the brick consolidated to a greater extent than can be effected by a single pressure.

The varieties of brickmaking machinery are too numerous to be separately noticed, however briefly, but the foregoing may suffice to illustrate the general principles involved in their construction. With suitable modifications, perforated or hollow bricks are frequently produced, on which there is a saving in cost of carriage, and also in mortar and labour.

'nburnt ricks. Among the objects at the International Exhibition of 1874 there were several varieties of brick prepared without burning, according to a process devised by Messrs Bodmer. They are made by intimately mixing certain materials of the nature of cements or mortars, and squeezing the mixture into the desired shape by hydraulic pressure in a specially-constructed machine. Sand and selenitic lime are the constituents of one kind of brick; these substances, together with Portland cement, of another; and a very serviceable kind of brick is prepared from blast-furnace slag, which, consisting chiefly of silicates decomposable by lime, is just as suitable for the purpose as the volcanic products, trass and pozzuolano, which have long been employed. The bricks give good results on application of the usual tests.

'loating ricks. The old invention of *floating bricks* (known to Pliny) was completely lost till M. Fabroni discovered they could be made from the earth known as fossil meal, which is abundant in Tuscany, and is found near Castel del Piano in the territories of Siena.

Ioffmann's ilns. For the drying and burning of bricks, the construction of kilns according to Hoffmann's method is a remarkable improvement of late years. These kilns are formed by a series of arched chambers connected by passages to one main chimney flue, each passage or flue having suitable dampers to regulate the heat at any desired point. Small coal, slack, or peat fuel may be used, which is fed in from the top of the kilns through small openings. The waste gases from the burning and cooling chambers are made to pass successively into other chambers and give out their heat before escaping to the chimney, thus completing the drying, and effecting a partial burning, of newly-made bricks before the actual firing of the chambers in which these latter are newly set. Such kilns are no doubt beyond the means of most brickmakers, but it is perhaps a question for consideration whether bricks must necessarily be burnt in immediate proximity to the spot where the clay is obtained.

In an instructive report on the manufacture of bricks, drawn up a few years ago by a committee of the Manchester Society of Architects, the following points were specified as requiring attention, in order to improve the character of the common brick:—(*a*) Greater care in cleaning the clay and in thoroughly tempering it; (*b*) variation in the size of moulds, so as to produce uniform sized bricks from various clays; (*c*) moulding the brick with material of such consistency that it may not become misshapen by the effects of its own gravity; (*d*) greater regularity of surface of the drying-ground; (*e*) protection from extreme variations of temperature and rain in drying; (*f*) less frequent and more careful handling in the process of drying, so as to preserve the edges; (*g*) a means of burning whereby the amount of firing shall be under control. In experiments on the absorption and retention of moisture, it was found that the bricks which parted most readily with their moisture at first were the longest in drying, and *vice versa*.

Tiles, being a thinner ware than bricks, have to be made of purer and stronger clay, and require more care in treatment; but the process of manufacture is not essentially different. The numerous varieties of tiles may be roughly arranged in three classes, viz., *paving tiles*, *roofing tiles* (including the flat plain tiles, the curved pantiles, hip, ridge, and valley tiles), and *drain tiles*. In weathering, the clay is spread in layers of about 2 inches thickness during winter, and each layer is allowed the benefit of at least one night's frost before the succeeding layer is put upon it. Sometimes the weathering is effected by sunshine. The comminuted clay is next placed in pits and allowed to mellow or ripen under water. Then it is passed through the pug-mill, and the tempered product, if necessary, *slung* (that is, cut in thin slices with a piece of wire fixed to two handles, in order to detect any stones), and then passed through the pug-mill again, after which it is generally ready for moulding. To take the case of *pantiles* (hand-moulded), the moulder turns the tile out of the flat mould on to the *washing-off frame*, on the curved surface of which, with very wet hands, he washes it into a curved shape. Then he strikes it with a semi-cylindrical implement called the *splayer*, and conveys it on this to the flat block where he deposits it, with the convex side uppermost, and, removing the splayer, leaves the tile to dry. The tile is afterwards beaten on the *thwacking-frame*, to correct any warping that may have occurred, and trimmed with the *thwacking-knife*. In the kiln, which is constructed with arched furnaces at the base of a conical erection called the dome, the tiles are closely stacked in upright position, on a bottom of vitrified bricks. The fuel used is coal, and the burning continues usually about six days. In making *pipe drain tiles*, the clay is first moulded to the proper length, width, and thickness, then wrapped round a drum; the edges are closed together, and the tile is carefully shaped by the operator's hand, sometimes assisted by a wooden tool. Tiles as well as bricks can be made by machinery; with suitable dies, almost any form of tile may be thus had, which is producible by the advance of a given section of clay parallel to itself. In other machines pressure is exerted on the clay in a mould. Tiles.

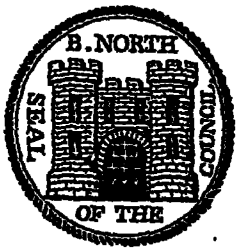
The manufacture of *tesseræ* and *encaustic tiles* has been brought to great perfection in recent times, through the enterprise especially of Mr Minton. It is a revival and extension of a very old art, which originated, probably, with the Greeks. The tesselated pavements of the Romans, of which many specimens are still extant, were formed of small pieces of stone or marble of various colours, bedded one by one in a layer of cement. The principle on which tesseræ are now made, is that dry and finely-powdered clay, compressed between steel dies, is changed into a very compact and hard solid body, a fact first observed by Mr Prosser in 1840. The solid pieces, which are thus produced in a screw-press, are enclosed in earthenware cases or pans, call *saggers*, and fired in a potter's kiln, after which they are ready for use, unless they are required to be glazed, in which case they are dipped in a glazing composition and again fired. The mode of setting the pieces differs essentially from the Roman method. In manufacture of the tiles called *encaustic*, in which various designs are produced by addition of clays of different colour from that of the ground, the clays first undergo sundry washings and purifications. A portion of the kind which is to form the ground first receives an impression, in the plastic state, from a plaster in relief. The bulk of the tile is made up Encaust tiles.

with coarser clay added in a frame, and this is solidified in a screw-press. Then comes the filling in of the design, which the maker does by spreading the coloured clay in a creamy or slip state on the indented surface. After a few days' evaporation, the surface is scraped or planed, and the tile passes successively to the drying house and the oven. The colours desired in encaustic tiles are sometimes those given by the clay in ordinary treatment, sometimes they are obtained by staining with manganese, cobalt, &c. The products of this branch of manufacture are much admired.

The fine ornamental bricks of various shape and colour known as *terra cotta* have of late been much used, especially in the facing of public buildings, and with the happiest effects. (A. B. M.)

BRIDAINE, JACQUES, a celebrated French preacher and home-missionary, was born in 1701 at Chuslan in the department of Gard. Though a rigid Catholic in principle, he gained the good-will of the Protestants of France by the boldness with which he advocated their cause on many occasions, and the personal kindness which he displayed towards many of their number during the persecutions to which they were exposed under the Regent Orléans and Louis XV. He accomplished no fewer than 250 evangelizing journeys through various parts of France, in the course of which he made himself universally popular, being possessed of a powerful though rugged eloquence. He was the author of a collection of *Cantiques Spirituels*, which has been frequently reprinted, and of five volumes of sermons, printed at Avignon in 1825. In the neighbourhood of this town he died in 1767.

BRIDGENORTH, a parliamentary and municipal borough and market town of England, in the county of Shropshire, on both sides of the Severn, 18 miles S.E. by E. of Shrewsbury. The river, which is here crossed by a handsome stone bridge of six arches, separates the upper from the lower town. The former is built on the acclivities and summit of a rock which rises abruptly from the river to the height of 180 feet, and gives the town a very picturesque appearance. The railway passes under by a long tunnel. On the summit is the tower of the old castle, leaning about 17 degrees from the perpendicular; two parish churches, one of which, St Leonard's, was rebuilt in 1862; and a large public reservoir. There are in the town a mechanics' institute, a public library—founded by the Rev. Mr Stackhouse, an infirmary, a jail, a theatre (1824), a market hall (1855), and a considerable number of schools and charities. It has manufactures of carpets, worsted, and tobacco-pipes, and some trade in agricultural produce. It returns one member to parliament. The population of the parliamentary borough amounted in 1871 to 7317; that of the municipal borough to 5876.



Arms of Bridgenorth.

Bridgenorth, or Brigge, is said to have been founded by Ethelfleda, the daughter of Alfred, and it was fortified with a castle and walls by Robert de Belesme, earl of Shrewsbury. On the earl's rebellion the town was besieged and taken by Henry I. in 1102; and in the reign of Henry II. the castle was dismantled. In 1646 the town, being held by a Royal garrison, sustained a remarkable siege by the Parliamentary forces, who at last obtained possession.

BRIDGEPORT, a seaport town in the county of Fairfield, Connecticut, United States, is situated on an arm of Long Island Sound, 58 miles N.E. of New York, in 41° 10′ N. lat. and 73° 11′ W. long. It has several iron-foundries and manufactures fire-arms, metallic cartridges, sewing-machines, carriages, harness, locks, blinds, &c. The coasting trade and the fisheries are both extensive. The bar at the mouth of the harbour, which is formed by the Pequonnock Creek, has 13 feet at high water. Bridgeport is the centre of an extensive system of railways, and steamboats ply between it and New York. The township was separated from Stratford in 1821, and the city, formerly called Newfield, was incorporated in 1836. Population in 1870, 19,835.

BRIDGES

§ 1. *Definitions and General Considerations.*—Bridges are structures designed to carry roads across streams, gullies, or roads. A viaduct may be distinguished from a bridge, inasmuch as the object of the former is to carry a road at a considerable elevation above the surrounding country, by means of structures, similar indeed to bridges, but in which the object of the open spans is to save expense rather than to cross some obstacle which could not be passed by a level road or embankment. The aqueduct is a structure similar to the viaduct, but employed to convey or support water. A culvert may be distinguished from a bridge as an opening, the primary object of which is to let water flow past a road or other obstacle, the object being similar to that of a large drain. A large culvert might be called a small bridge, and a bridge having long approaches with many spans might be called a viaduct. The present article will treat only of Bridges.

Every bridge may be divided into two parts, the *substructure* and the *superstructure*. The substructure of a bridge consists of foundations, abutments, and piers. The end supports of the bridge are the abutments, and the intermediate supports are called piers. Piers and abutments rest on foundations in the ground. A bridge of one span has no piers. The superstructure of a bridge consists of the roadway and the beam, arch, or chain used to carry the roadway from support to support.

The dimensions and design of a bridge depend on the nature of the obstacle to be crossed and on the traffic to which the road over the bridge is subject. The engineer is usually bound to design the cheapest structure which will perform the required duties; he has, therefore, in each case to consider whether a small number of large spans or a large number of small spans will be cheaper. Large spans will be desirable where foundations cannot be easily obtained, or where the height of the structure is great. The engineer has also to determine whether, considering the prices of materials, labour, and transport, one or other form of super structure is to be preferred. The traffic to be accommodated will determine the width of the bridge and the load which the superstructure must bear. In many cases it will also be the duty of the designer to endeavour to combine beauty with utility. Beauty does not require ornament or expense, but demands, what may be more difficult to supply, correct taste in the designer.

In Great Britain law prescribes the following minimum dimensions for the over and under bridges of railways. (An *over bridge* is one in which the road goes over the railway; an *under bridge* one in which the road goes under the railway.) *Over bridges.*—Width: turnpike road, 35 feet; other public carriage road, 25 feet; private road, 12 feet. Span over two lines (narrow gauge), generally about 26 feet; head room, 14 feet 6 inches above outer rail. *Under bridges.*—Spans: turnpike road, 35 feet; other public carriage road, 25 feet; private road, 12 feet. Head-room: turnpike road, 12 feet at springing of arch, and 16 feet throughout a breadth of 12 feet in the middle; for

public road, 12 feet, 15 feet, and 10 feet in the same places; private road, 14 feet for 9 feet in the middle; for exceptions the Acts must be consulted. In designing a bridge to cross a stream care must be taken to insure that the openings are suitable for the maximum floods.

The *load* which the superstructure of a bridge has to carry in addition to its own mass may be estimated as follows:—

1. For a *public road;* one hundredweight per square foot will represent the weight of a very dense crowd. This is greater than any load which ordinary carts or vans will bring on the bridge, but of late years traction engines and road rollers have been introduced, and a weight of perhaps 10 tons on each wheel on one line across the bridge ought in future designs to be provided for. The bridge must be strong enough to bear this maximum weight applied at any point, and also to bear all possible distributions of the crowd. A bridge might be fit to carry the crowd uniformly distributed over its surface, and yet fail when the crowd covered one-half of its length or width.

2. For a *railway;* the maximum passing load on each line of rails may be taken as the weight of a train composed exclusively of locomotives. The bridge must be fit to bear this load distributed in all possible ways along the line. For spans above 60 feet on the usual 4 feet $8\frac{1}{2}$ inches gauge this load may generally be taken as equivalent to 1 ton for each foot in length of each line of way, or in engineering language, "one ton per foot run." Where a very heavy class of locomotives is in use $1\frac{1}{2}$ tons per foot run must be provided for. For small spans the distribution of the load as a locomotive passes is such that the above allowance is barely sufficient. For very small spans of 8 or 10 feet the maximum passing load is a little more than the weight on the driving axle of the locomotive, or say 14 tons.

§ 2. *Classification.*—Bridges are classed, according to the design of their superstructure, as *girders, arches,* and *suspension bridges.* A beam of wood crossing a stream, a brick arch, and a platform hung to a flexible wire rope are common examples of the three types. The essential distinction between the three types may be said to be, that in all forms of the suspension bridge the supporting structure (*i.e.*, the wire rope in the above example) is *extended* by the stress due to the load; in all forms of the arch the supporting structure (*i.e.*, the ring of bricks in the above example) is *compressed* by the stress due to the load; and in all forms of the beam or girder the material is partly extended and partly compressed by the flexure which it undergoes as it bends under the load,—thus when a beam of wood carrying a load bends, the upper side of the beam is thereby shortened and the fibres compressed, while the lower side of the beam is lengthened and the fibres extended.

Beams or *Girders* may be of various materials,—wrought iron, cast-iron, and wood being chiefly employed.

Arches may be of masonry, or they may be of wrought or cast iron or steel, in which case the compressed sector of a ring is usually a continuous and stiff structure.

Suspension bridges are made of wire ropes or of separate links of wrought iron or steel pinned together so as to form a chain. The metal beam, arch, or suspension bridge may be a continuous structure or an open frame; we shall also find that in some designs the several simple types are combined so as almost to defy classification.

Whatever design be adopted, the strength or efficiency to carry a given load depends on similar considerations. The designer selects that form of superstructure which the principles of statics show to be most desirable; he calculates the maximum stress which the load can produce on each part, and then so distributes his material that the maximum intensity of stress on every part shall be a definite fraction of the ultimate strength of the material. In metal structures, where the above principle can be very perfectly carried out, this fraction varies from one-sixth to one-third, according to the certainty with which the stresses and strength of the materials are known. In stone structures the engineer has greater difficulty in calculating the stresses on each part, and relies more on empirical rules based on long experience.

I. Strength and other Properties of Materials employed in Bridges.

§ 3. *Classes of Stress.*—There are three kinds of stress, due to tension, compression, and shearing. Tension tends to cause failure by the extension or lengthening of the part strained; compression tends to cause failure by the crushing of the part strained; and shearing stress tends to cause failure by the sliding of one part of the piece across the other from which it is shorn off.

§ 4. *Tenacity, or Strength to resist Tension.*—When tension is applied to a rod or link of any material so as to be resisted equally by each element of any imaginary section in a plane normal to the direction of the pull, this section, which is called a *cross section,* is said to be subject to a stress of *uniform intensity.* This intensity p is equal to the quotient of the whole pull P divided by the area S of the cross section, or

$$1. \quad . \quad . \quad . \quad . \quad . \quad . \quad p=\frac{P}{S}.$$

The ultimate strength of a rod subject to uniform stress is proportional to the section S, and the ultimate strength of the material is measured by the maximum intensity of stress which it can bear, or in other words, by the stress which the unit area of cross section can bear; for example, if the unit of force employed be the weight of a ton, and the unit of area the square inch, the strength of materials will be measured in tons per square inch, or by the number of tons which will just tear asunder a rod one inch square, great care being taken that the load is so hung on the rod as to bear equally on all parts of the cross section.

The following table gives in tons or lbs. per square inch the ultimate strength f_t of some of the materials used in bridges:—

Table I.—*Tensile Strength of Materials* $= f_t$.

Name of Material.	Tons per sq. inch.
Wrought Iron Plates	20 to 25
" " Bars and Bolts	25 to 30
" " Wire	30 to 45
Steel Plates	30 to 40
Steel Rivets	41 to 48
Steel Wire	50 to 100
Cast-iron	6 to 8
Red Pine	5·1 to 6·3
Larch	4 to 5·5
Oak	4·5 to 8·5
Teak	6 to 9
	Lbs. per sq. inch.
Brick (specimens of)	250 to 300
Basalt "	1000
Sandstone "	285
Common Mortar	10 to 50
Hydraulic Mortar	85 to 140
Roman Cement, 12 months old	46
Portland Cement, 7 days old	270
" " 12 months old	350 to 470

The ultimate strength P_1 of a bar with the cross section S to resist a stress uniformly distributed over that section is given in terms of f_t by the expression—

$$2. \quad . \quad . \quad . \quad . \quad . \quad . \quad P_1=Sf_t.$$

Table I. gives some idea of the tensile strength of the materials, but for a full comprehension of the subject special treatises, or the article on the Strength of Materials,

must be consulted. No two specimens of any material ever give exactly similar results. The various brands of iron differ much; different specimens of steel differ still more; the strength is greater when the stress is applied along than when it is applied across the fibres. Iron or steel forged or drawn *down to a small cross section* is stronger than when in large masses; the material in small castings is stronger than in large castings run from the same batch of metal; the skin is stronger than the rest of a casting. The variations to be expected in timber are still greater than those in metals, and the values for stones or bricks must in each case be specially determined by experiment on the special kind to be used. These warnings are applicable to the subsequent tables, which give the strength of materials to resist other kinds of stress.

§ 5. *Strength to resist Crushing.*—The law given for tension applies to the compression of blocks, so that the strength f_c of a material to resist crushing may also be measured in tons per square inch. Thus the ultimate strength P_1 of a block of the cross section S, subject to a uniform stress, is given in terms of f_c the strength of the material per unit of section by the expression—

1. . . . . . . $P_1 = Sf_c$.

This equation is not applicable to blocks or struts of iron in which the ratio of the shortest side of the cross section to the length is less than about 1 to 5, nor to struts of timber in which this ratio is less than about 1 to 10. When this limit is passed the strut bends before failing (*vide* § 57), and whenever this occurs the essential condition that the stress shall be uniformly distributed no longer obtains. The flexure increases the stress on the inside of the curve assumed by the strut or pillar, and diminishes it on the outside; but the strut will fail as soon as *any part* of the cross section is subject to a crushing stress of greater intensity than f_c.

TABLE II.—*Ultimate Strength to resist Crushing* $= f_c$.

Name of Material.	Tons per sq. inch.
Wrought Iron	15 to 18
Cast-iron	37 to 65
Steel Plates	90
Red Pine	2·4 to 2·76
Larch	2·5
Oak	2·7 to 4·5
Teak	5·4
Bricks—	
	Lbs. per sq. inch.
Portland Cement, 3 months old	2460
" " 9 "	3750
Gault Bricks	710 to 930
Best Whites	300
" poor quality	60
Best Reds	490
Best Fire Bricks	930
Best Blue	1260
Stones (specimens)—	
Portland Stone (on bed)	2630
" " (against bed)	2390
Bramley Fall (on bed)	5100
" " (against bed)	2950
Yorkshire Landing (on bed)	5380
" " (against bed)	5850
Granite	5500 to 11,000
Scotch Basalt	8300
Greenstone	17,200
Sandstones (ordinary)	3300 to 4000
Chalk	330 to 500
Béton	420 to 580

§ 6. *Strength to resist Shearing.*—Let a bar AD of any material be firmly supported on C, as shown in fig 1, and let a strong tool B, say of steel, descend upon it in the direction of the arrow, with force sufficient to sever the part D from the part A, so that the surface dividing the two parts is in the plane of the face of C. This tool is said to *shear* the bar, and the resistance which the bar opposes to this stress is called its strength to resist shearing. The tools practically used to shear are not quite square at the edge, and therefore *cut* slightly, but for true shearing the lower face ought to be square, and the tool should come down close

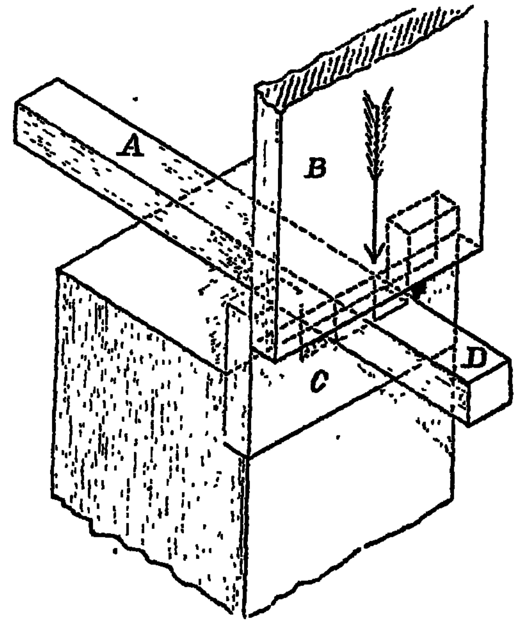


Fig. 1.

to the support, so that the inner face of the tool slides on the outer face of the support.

Fig 2. represents two iron links joined by an iron pin. If the links are pulled asunder the pin will be shorn

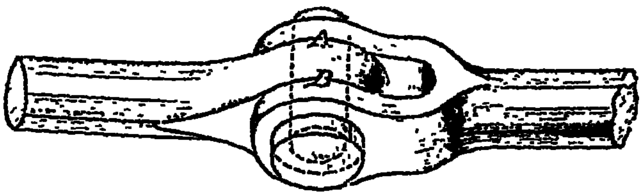


Fig. 2.

at two places, A and B, and the whole section shorn will be twice the cross section of the pin.

Fig 3 shows a joint where the pin would be shorn in four places—A, B, C, and D.

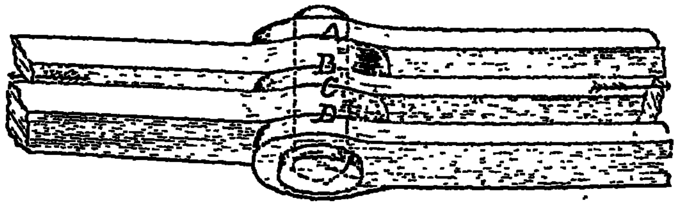


Fig. 3.

The strength of a piece of any material to resist shearing is usually assumed by engineers to be proportional to the cross section to be shorn through, and each material may consequently be said to have a certain shearing strength per square inch; in other words, the ultimate shearing strength of the material is the *intensity* of stress required to shear it asunder. If, therefore, P_1 be the ultimate strength of a bar of cross section S to resist shearing in n places, and if f_s be the ultimate strength of the material, we have the expression—

1. . . . . . . $P_1 = nSf_s$.

The assumption on which this equation is founded is not strictly correct; indeed, the actual shearing described does not correspond with any simple homogeneous stress, and the form of the cross section shorn through must exercise considerable influence on the strength of the piece to resist shearing. In a round pin the maximum intensity of shearing stress is $\frac{4}{3}$ of the mean intensity, and in a rect-

angular pin $\frac{3}{8}$ of the mean intensity. See STRENGTH OF MATERIALS.

The pins which join the links of suspension bridges, and the rivets which join the wrought iron plates of girder bridges, are subject to shearing stress, and the area to be shorn through must be made sufficient to bear the total shearing stress on that part of the structure. Wood is strong to resist tension, and would be much employed for ties but for the difficulty of taking hold of the ends of the tie in such a way that these ends shall not fail by being shorn.

Fig 4 shows the end of a balk of wood with a strap bolted to it. This strap would be torn off by the shearing

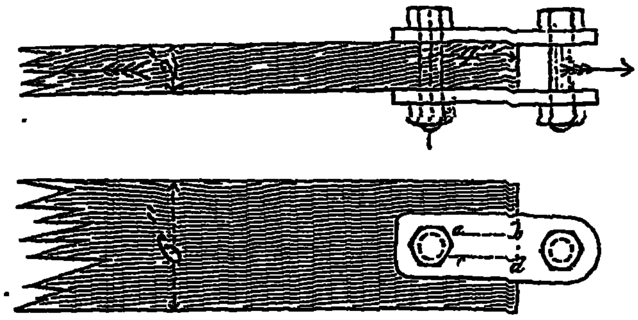


Fig. 4.

of the wood along the dotted lines *ab* and *cd*, with a stress which would be much less than that required to overcome the tenacity of the wood; for if the dimensions of the balk of pine are 6 in. by 2 in. with an inch hole, its tensile strength will be 10 × 5 or 50 tons, while if the bolt be 1 inch diameter, and be placed 4 inches from one end, it could be torn out by shearing 16 inches of the wood; now each inch will only resist a shearing stress of say 600 ℔, so that the bolt would be torn out with only 4·3 tons. Thus at least eleven such bolts, each 4 inches from its neighbour, and occupying 3 feet 8 inches in length of this balk, with an iron strap of corresponding length, would be required to render the full strength of the balk as a tie available. A similar difficulty is met with when timber is joined, as in fig. 5, where shearing would take place along the dotted lines AB or CD.

Fig. 5.

TABLE III.—*Ultimate Strength to resist Shearing* = *f*.

Name of Material.	Tons per sq. inch.
Cast-iron	14·5
Wrought Iron	22
Steel Rivets	30 to 36
Red Pine	·22 to ·35
Larch	·43 to ·75
Oak (British)	1

The strengths given here for wood are those obtained by testing the resistance to shearing along the grain.

The strength of wrought iron to resist shearing may be taken as practically equal to its strength to resist tension—an assumption which facilitates the design of rivetted and other joints.

The strength of steel to resist shearing is less than its strength to resist tearing in the ratio of three to four approximately. Rivets employed to joint steel plates require, therefore, to be larger or more numerous than those employed for iron plates of equal dimensions.

§ 7. *Elasticity.*—When a piece of any material is under tension or compression, it is lengthened or shortened by the stress, and the amount of extension or compression for the same length and stress varies with different materials. Approximately correct results are obtained by assuming that the extension or compression of a given piece of the material of uniform cross section, under a uniformly distributed stress constant throughout its length, is proportional to the length of the piece and to the intensity of the stress.

Let p be the intensity of the stress in tons per square inch, let l be the length of a specimen of a given material in any unit, and let e be the extension or compression observed in the same unit. Then the expression $\frac{pl}{e}$ is, on the above assumption, a constant quantity, and this ratio is experimentally found for many materials to be sensibly constant for stresses which do not approach the ultimate strength. This constant ratio E has received the name of modulus of elasticity, and is generally expressed in tons per square inch, this being the unit in which p is measured. Thomson and Tait (*Elements of Nat. Phil.*) call E the "measure of longitudinal rigidity," a better name than the modulus of elasticity. The actual extension or compression e of any piece of a structure is given by the expression—

$$1. \quad \ldots \ldots \quad e = \frac{pl}{E},$$

where p is in tons per square inch; e will be given in terms of the unit in which l is expressed.

TABLE IV.—*Modulus of Elasticity* = E.

Name of Material	Tons per sq. inch.	Name of Material.	Tons per sq. inch.
Wrought Iron	10,000 to 13,000	Slate	5800 to 7100
Iron Wire	11,500	Red Pine	650 to 850
Wire Ropes	6700	Larch	400 to 600
Steel Bars	13,000 to 19,000	Oak	585 to 780
Cast-iron	5250 to 10,000	Teak	1070

The modulus of elasticity is very generally assumed as equal for extension and compression, which is nearly true for wrought iron and steel under any stress to which these materials can be safely subjected. The principle of continuity shows that there can be no difference in the value of E for positive and negative stresses so long as these are small. The law according to which E varies as p changes is not accurately known for any material. When the stress is small the value of E appears to be more nearly constant in wrought iron than in cast-iron, but the change in the value of E corresponding to a change from a small stress to the ultimate stress is greater in wrought iron than in cast-iron. The values in the table cannot be depended upon to give very exact results, as the elasticity of different specimens of the same material varies considerably; the theory is wholly inapplicable when the breaking strain is approached; the engineer, however, seldom requires to calculate the extensions or compressions when the stress is even so great as one-third of the ultimate strength. For the same reason the engineer need seldom take account of the permanent set caused by stresses exceeding those within which the material may be considered perfectly elastic. B. D. Stoney, in his work on the theory of strains on girders, gives an excellent summary of what is known experimentally concerning *set* and the modulus of elasticity.

§ 8. *Strength to resist Tension or Crushing when the Stress is not Axial.*—When the resultant of a stress passes through the centre of surface of the cross section of the piece of a structure, and is normal to the cross section, the stress is called *axial*, and it is usually assumed that this stress will be borne uniformly by all the elements into which the surface of the cross section may be conceived as divided. This is not necessarily true, but it is approximately true for the forms usually employed by engineers. When the stress is not axial it cannot be considered, even approximately, as uniformly distributed; the greatest intensity of stress will occur towards that edge of the cross section which is nearest

to the point where the resultant meets the plane of the cross section. The following considerations allow the maximum intensity of stress to be approximately calculated in most of the cases which are practically met with. 1. Let the cross section (fig. 6) have an axis of symmetry XX_1, and let YY_1 be an axis passing through the centre of gravity of the surface at right angles to XX_1; the axis YY_1 will be called the *neutral axis*. 2. Let the resultant stress pass through some point A in the axis XX_1, at a distance x_0 from the axis YY_1. 3. Let the material be such that its modulus of elasticity is constant under all the intensities of stress which result from the given total stress; then calling the whole force P, the area of the cross section S, the mean intensity of stress p_0, the maximum intensity of stress p_1, the maximum distance of any point of the cross section from the axis x_1, and representing by I the moment of inertia (*vide* § 9) of the surface of the cross section round the axis YY_1, we observe—first, that

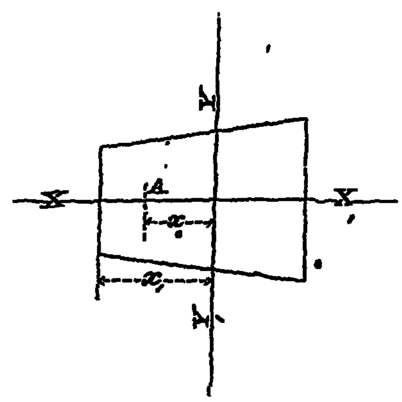


Fig. 6.

$$p_0 = \frac{P}{S};$$

and secondly, that the non-axial force may be assumed to produce a uniformly varying stress, the maximum intensity of which will occur at the distance x_1 from the neutral axis on the same side as x_0 is taken. This uniformly varying stress is equivalent to a uniformly distributed stress of the intensity p_0 and a couple of the moment aI, where a is the constant rate of increase of the stress. We also know by the principles of mechanics that the force P applied at a distance x_0 from the centre might be replaced by an equal force P at the centre and a couple of the moment Px_0. Hence we have—

$$1. \quad . \quad . \quad . \quad . \quad Px_0 = aI, \text{ or } a = \frac{Px_0}{I}.$$

But the maximum intensity of stress due to the couple will be $x_1 a$, *i.e.*, $\frac{Px_0 x_1}{I}$, and the maximum stress p_1 may be considered as consisting of two parts,—first, the mean intensity of stress p_0, and secondly, the maximum stress due to the couple. Hence we have—

$$2. \quad . \quad . \quad . \quad p_1 = p_0 + \frac{Px_0 x_1}{I} = p_0\left(1 + \frac{x_0 x_1 S}{I}\right).$$

This equation shows that the maximum intensity of stress increases very rapidly as x_0 increases, and it must be borne in mind that the ultimate strength of any member of a structure is determined, not by the mean stress, but by the maximum stress on any part, for when the part most strained yields the structure is weakened thereby, and this failure must continue to extend until the whole yields.

§ 9. *Note on the Value of* I, *the Moment of Inertia of the Cross Section.*—Suppose the cross section divided into a very large number of rectangles, so small that the distance x of the centre of each from the neutral axis may be taken as sensibly expressing the distance of every part of the rectangle; then I is the sum of the products of the areas of all the elementary rectangles each multiplied into the square of its distance from the neutral axis; or calling the area of the elementary rectangle $\Delta x \Delta y$,—

The subjoined table gives the values of I for some simple geometrical forms; the axis in all cases passes through the centre of gravity of the surface.

TABLE V.—*Moment of Inertia* = I.

Surface	Neutral Axis.	I.
Circle, radius r	Diameter	$\frac{1}{4}\pi r^4$
Square, side d	Parallel to one side	$\frac{1}{12}d^4$
Square, side d	Diagonal	$\frac{1}{12}d^4$
Rectangle with sides d and b	Parallel to b	$\frac{1}{12}bd^3$
Triangle, base b, height d	Parallel to b	$\frac{1}{36}bd^3$

Whenever a cross section can be conceived as obtained by the addition or subtraction of one surface to or from another, both surfaces having a common neutral axis, the value of I for that cross section is got by adding or subtracting the value of I for one surface to or from that for the other; thus for a ring surface, with external and internal radii r and r_1, the value of I is—

$$\tfrac{1}{4}\pi(r^4 - r_1^4).$$

The value I_1 of the moment of inertia of any plane surface S round an axis in its own plane parallel to the neutral axis, and at a distance x_0 from that axis, is given by the equation—

$$2. \quad . \quad . \quad . \quad . \quad . \quad I_1 = I + Sx_0^2,$$

where I is the moment of inertia of the surface round a neutral axis, *i.e.*, round a parallel axis passing through the centre of gravity of the section. We can thus obtain the value of the moment of inertia I of complicated cross sections whenever we can divide these into rectangles, circles, or triangles; for then, calling s_1, s_2, s_3, &c., the surfaces of each elementary part, x_1, x_2, x_3 the distances of the centre of each part from the neutral axis of the whole cross section, and I_1, I_2, I_3, the moments of inertia of each element calculated round its own neutral axis, we have the moment of inertia of the whole round its neutral axis—

$$3. \quad . \quad . \quad . \quad . \quad . \quad I_0 = \Sigma I + \Sigma s x^2.$$

§ 10. *Specific Gravity of Materials.*—In order to calculate the load due to the superstructure of a bridge, and the stability due to the weight of the abutments and anchorages of arches and suspension bridges, it is necessary to know the specific gravity of the materials employed—specific gravity being for the purposes of the present article defined as the weight of the material in lbs. per cubic foot. The following are the most useful numbers:—

TABLE VI.—*Weight per Cubic Foot of Different Materials*

Name of Material.	Weight of cubic foot in lbs.
Water (pure) at 39°·4. Fahr.	62·425
Basalt	187·3
Brick	100 to 135
Brickwork (ordinary)	112
Chalk	117 to 174
Clay	120
Granite	164 to 172
Limestone and Marble	169 to 175
Masonry	116 to 144
Mortar	86 to 119
Mud	102
Sandstone	130 to 157
Sand (damp)	118
Sand (dry)	88·6
Asphalt	156
Concrete (ordinary)	119
Concrete in cement	137
Earth	77 to 125
Slate	175 to 181
Trap	170
Cast-iron (average)	444
Wrought Iron (average)	480
Red Pine	30 to 44
Larch	31 to 35
Oak (European)	43 to 62

imperfect manner. To make the frame into a true beam, this tendency of the loaded frame to slip through between the others must be counteracted by *tongues*, T, T_1, T_2, projecting from one frame and working in a groove in the neighbouring frame (*vide* § 19). Each tongue should be made so that it does not abut against the bottom of the groove, and is thus incapable of resisting any horizontal force—it must neither prevent the whole beam nor any part of it from being extended or compressed longitudinally.

The structure will now be found capable of carrying weights as a beam. It deflects or bends as in fig. 11

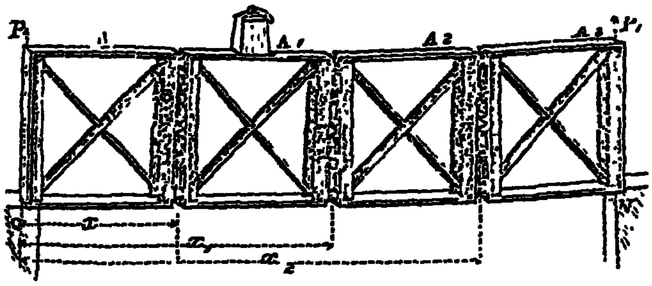


Fig. 11.

under the action of a load on A_1; all the pieces of india-rubber above the centre of the beam are then compressed; all those below the centre are then extended; and at the sections between the frames the horizontal internal forces are wholly met by the elastic reaction due to these horizontal extensions and compressions.

At any one section, say at a distance x_1 from the support Q, the pieces c_1 and d_1 are just as much compressed as the pieces $b_1 a_1$ are extended; the equal and opposite parallel resultants of these forces consequently constitute a couple, and the moment of this couple must be equal to the moment of the couple tending to bend the beam at this section, or to what is called the *bending moment*; now the *bending moment* in this simple case is due to the upward vertical reaction P_1 at N and the equal downward force with which the frame A_1 bears on the tongue T_1; for it is clear that, neglecting the weight of the frame, if a weight W on frame A_1 is borne by two forces P and P_1 at the two piers, the tongue next N must also bear a vertical force P_1 and the tongue next Q a vertical force P. The stresses borne by the india-rubber pieces are exactly the same as if the frame A_1 were firmly held, and a vertical force P_1 applied to pull up the right hand part of the beam, while the tongue T_1 acted as a hinge; the moment tending to turn the right hand part round in a left-handed direction would be $P_1 (L - x_1)$. This moment is resisted by the elasticity of the india-rubber, which must exert an equal and opposite moment round the same point. Calling s_1, s_2, s_3 the sectional areas of the pieces of rubber, and y_1, y_2, y_3 their distances from the axis where the section is neither extended nor compressed, and p_1, p_2, p_3 the intensity with which each piece is strained, the moment due to the elasticity of the pieces of rubber tending to turn back the left hand part of the beam in a right-handed direction will be Σpsy. Now, if the modulus of elasticity of the rubber is constant, the stresses p_1, p_2, p_3 will be proportional to their distance from the unstrained axis; thus if b_1 is 18 inches from the axis and c_1 only 9 inches, b_1 being shortened twice as much as c_1, the stress on b_1 will be twice that on c_1, and calling a the stress at unit distance from the axis we have $p_1 = ay_1$ and $p_2 = ay_2, p_n = ay_n$, so that we may write $\Sigma psy = a\Sigma sy^2$ as the expression for the moment of the elastic forces. Hence equating the bending moment and the moment of the elastic forces, we have—

1. . . . . $P_1(L - x) = a\Sigma sy^2$.

From this equation when the load is given we may determine a, and hence the intensity of the stress $p = ay$ at any distance y from the axis. If this intensity is less than the safe stress for the material, the beam is, at the section considered, strong enough to bear the load so far as the horizontal extending and compressing forces are concerned.

Thus if the dimensions of the beam be those given above and it be supported so that L may be 6 feet and the distance x_1 2 feet 3 inches, the distance y of the outermost piece of rubber from the unstrained axis 8 inches, the weight 50 ℔, and the section of the rubber in each row 2 inches (two cylinders side by side, each with a section of 1 inch) we shall have as the numerical values in the above equation, neglecting the weight of the frame itself (P_1 being nearly = 18·7), 18·7 × 45 in. $= a\,(4 \times 8^2 + 4 \times 4^2)$ from which $a = 2{\cdot}64$; then the force supported by each inch of either of the rows of rubber a_1 or d_1 will be $p = 8 \times 2{\cdot}64 = 21{\cdot}12$ ℔; the stress on each of the inner rows will be half this amount; the same equations give the load which (so far as that particular section is concerned) can safely be placed on the frame A_1 consistently with a given stress per square inch on the rubber. The strength required in the tongue T_1 is still more easily found, the stress tending to shear it off is P_1, and it must have a sufficient cross section to bear that shearing stress. Similar reasoning would allow us to calculate the strength of our beam at either of the two other sections where the india-rubber pieces and tongues are placed. The general relation between the external and internal forces in any beam is similar to that illustrated by the model; at any section the moment due to the elastic forces must balance the moment due to the external forces tending to bend the beam at that section. The problem, therefore, of determining the strength of a beam at any section resolves itself, so far as the horizontal forces are concerned, into finding expressions for these two moments and equating them. The equation thus stated will give the maximum horizontal stress thrown on the material of a given girder by a given load, or it will give the maximum load on a given girder consistent with a safe stress on the material, or if, as is generally the case in bridges, the load and maximum safe stress on the material are given, the equation will allow us to fix the dimensions required for the cross section of the beam so far as the *horizontal forces are concerned*. The provision to be made for resisting the shearing stress for which the tongues are required in the model will be explained in § 19.

In any solid beam the stresses do not divide themselves into horizontal and vertical components. This division is made by the engineer to simplify his calculations. In the beam the actual stress at any point will be the resultant of the horizontal stress (borne by the india-rubber in the model) and the vertical stress (borne by the tongue in the model). The diagram, fig. 12, shows the direction of the resultant stress at each point of a beam of rectangular cross section. The curves are called the lines of principal stress.

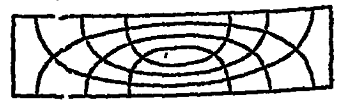


Fig. 12.

§ 14. *Bending Moment and Moment of Elastic Forces or Moment of Stress.*—The bending moment for a given section of a given beam under a given distribution and magnitude of load is the sum of the moments, taken relatively to the section, of all the external forces acting on one of the two segments into which the section divides the beam. It is a matter of indifference which segment is considered, but the moment on one segment will be positive and that on the other negative. Let x be the distance of the section from the left hand abutment Q of any beam of span L (fig. 13). Let P be the load borne by abutment Q, and P_1 the load borne by

abutment N. Let the load on the beam, including the weight of the beam, be divided into any number of equal or unequal parts. Let those loads which lie to the left of the

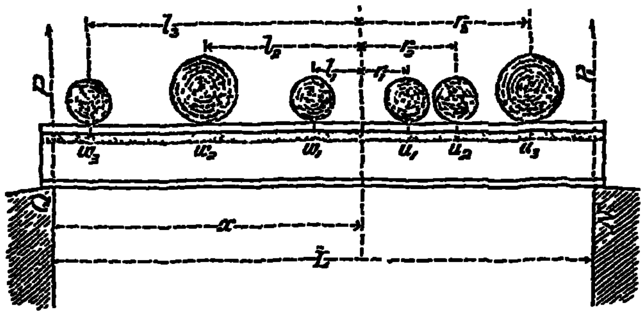


Fig. 13.

section be called w_1, w_2, w_3, &c., and let the distances of their centres of gravity from the section be called l_1, l_2, l_3. Let those loads which are to the right of the section be called u_1 u_2, u_3, and let their distances from the section be called r_1, r_2, r_3 &c. Let the bending moment at the section be called M, then by the above definition

1 . $M = Px - \Sigma wl = \Sigma ur - P_1(L-x)$.

This bending moment is resisted at the section by the elastic forces in the beam called into play by compression at the top and extension at the bottom, or, in other words, called into action by the stresses on the material. Limiting our consideration to those cross sections which have a vertical axis of symmetry, and to those materials which have a constant modulus of elasticity for tension and compression, it is easy to find a general expression for the moment of the elastic forces, which will hereafter be designated by the letter μ. Let the horizontal axis ZZ_1 (fig. 14) be a line along which the material is unstrained,—

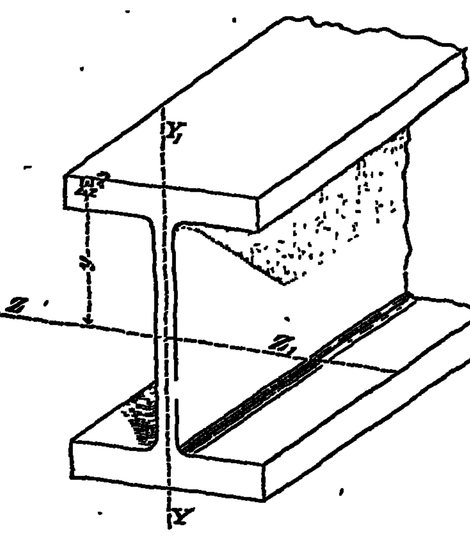


Fig. 14.

all the portions above this line being compressed, and all the portions below this line being extended. Conceive the section divided into little elementary surfaces, the area of each being equal to the product of the little elementary length Δy into the little elementary length Δz, the force exerted by the elasticity of this element will be proportional to its area $\Delta y \Delta z$ and to its distance y from the axis ZZ_1, for the longitudinal extension or compression is directly proportional to this distance; then calling a, as before, the rate at which the stress increases with the increase of y, or in other words the intensity of the stress at the unit distance from ZZ_1, we shall have for the force exerted by each element the expression $ay\Delta y\Delta z$. Now, as the section is not moved as a whole along the beam in either direction, we must have $\Sigma ay\Delta y\Delta x = 0$, that is to say, the sum of the positive must be equal to the sum of the negative forces. Let the constant quantity $a\Delta y\Delta x$ be conceived as the weight w of a thin plate of the area $\Delta y\Delta x$, the moment of this weight relatively to the axis will be wy, but as we have the sum of the moments $\Sigma wy = \Sigma ay\Delta y\Delta x = 0$, the axis ZZ_1 round which these moments are taken must pass through the centre of gravity of the section. This axis is called the *neutral axis* of the beam (*vide* § 18). The expression for the force exerted by each element being $ay\Delta y\Delta x$, the moment of this force, or, in other words, for the moment due to the stress, is given by the expression $ay^2\Delta y\Delta z$; then for the moment μ of all the forces round ZZ_1 we have—

2. . . . . $\mu = a\Sigma y^2\Delta y\Delta z = aI$,

where I is the moment of inertia of the surface of the cross section. This expression μ is Rankine's moment of resistance to flexure; it may also be called the moment of the elastic forces, or, as suggested by Professor Kennedy, the moment of stress.

The greatest intensity of stress p_1 occurs at the greatest distance from ZZ_1, or at the distance $\frac{1}{2}d$ if the depth of the beam be called d, and the axis ZZ_1 be equidistant from top and bottom. In this case we have—

$$p_1 = \frac{ad}{2}, \text{ or } a = \frac{2p_1}{d};$$

hence we may write for sections with two axes of symmetry, and for materials having equal strengths and constant moduli of elasticity under tension and compression—

3. . . . . $\mu = 2\,\dfrac{p_1 I}{d}$.

Now, the general condition of equilibrium between the external forces and the elastic forces at the section is simply $M = \mu$, hence when the beam does not break we have also—

4. . . . . $M = \dfrac{2p_1 I}{d}$.

Whenever the amount and distribution of load on a given girder is known the bending moment M is to be calculated from equation 1, and then equation 4 allows us to calculate p_1; or if we know the value of f, the ultimate strength of the material to resist tension and compression, this equation enables us to find what moment M_1 is required to break the beam at that section, and therefore what load distributed in a given way the beam can bear; thus we have—

5. . . . . $M_1 = \dfrac{2fI}{d}$.

In a beam of uniform strength the value of $\dfrac{2fI}{d}$ will at every section be equal to the value of M_1, the moment due to external forces at that section.

When the material is not equally strong to resist tension and compression, let f_t and f_c be the two strengths (per unit of cross section), but let the modulus of elasticity be assumed constant as before. Then, as above, the unstrained axis will be the axis passing through the centre of gravity of the section, and the intensity of stress at any distance y above or below that axis will be ay; let y_c be the distance of the uppermost element of the cross section from the horizontal axis, and let y_t be the distance of the lowermost element. Then the greatest stress will occur at the top if y_c be greater than y_t, but at the bottom if y_t be greater than y_c; since, however, the material is not equally strong to resist tension and compression, it does not follow that it will give way where the stress is greatest, and the beams will yield first at that edge where the ratio $\frac{y}{f}$ is greatest.

We must, therefore, on a beam of this kind ascertain whether $\frac{y_c}{f_c}$ or $\frac{y_t}{f_t}$ is the greater, and replace $\frac{d}{2}$ in equations 3 and 4 by the value of y in the larger of the two expressions. Having selected y and f in this manner, we have—

$$6. \quad \ldots\ldots \quad M_1 = \frac{fI}{y}.$$

§ 15. *Modulus of Rupture.*—If the above hypothesis of a constant modulus of elasticity in a given material under both descriptions of stress, and under stresses of all magnitudes, were accurate, we should require no fresh experiments to determine the values of f_c and f_t; these would be already known from direct experiments on tension or compression. For both wrought and cast iron beams of the maximum strength, such as will be described hereafter, experiment gives results closely in accordance with strengths calculated by equation 6; and for wrought iron beams the hypothesis appears to be approximately true when tested by experiment with any form of beam. But it is usual, in calculating the strengths of beams or bars of simple rectangular or circular cross section, to assume that y is equal to $\frac{1}{2}d$ and to employ equation 5 instead of equation 6. The imperfection of the theory is then to some extent corrected by determining f from direct experiments on solid rectangular bars. The value of M_1, I, and d being known, f is calculated from equation 5, and the number thus determined has received the name of modulus of rupture.

TABLE VIII.—*Modulus of Rupture = f (Rankine).*

Name of Material.	Lbs. per sq. inch.
Wrought Iron Plate Beams	42,000
Cast-iron Solid Bars	33,000 to 43,000
Fagersta Steel (Kirkaldy)	110,000 to 191,000
Red Pine	7100 to 9540
Larch	5000 to 10,000
Oak (British and Russian)	10,000 to 13,600
Indian Teak	14,770
Sandstone	1100 to 2360

Experiments on the modulus of rupture have generally been made by hanging weights at the centre of a rectangular bar, supported at both ends, and increasing the weights till the bar breaks. Then let b and d and l be the breadth, depth, and length of the bar in inches, and W the breaking weight. M is a maximum at the centre, and, neglecting the weight of the bar, is equal to $\frac{1}{4}Wl$; substituting the value of I for a rectangle in equation 3, we get

$$\mu = \tfrac{1}{6}fbd^2,$$

and equating M and μ we have—

$$1. \quad \ldots\ldots \quad f = \frac{3Wl}{2bd^2},$$

or, if the span is measured in feet and called L_1, while b and d are measured in inches, we have—

$$2. \quad \ldots\ldots \quad f = 18\,\frac{WL_1}{bd^2}.$$

Hence the modulus of rupture is stated by Rankine to be "eighteen times the load required to break a bar of 1 inch square, supported at two points 1 foot apart, and loaded in the middle between the points of support."

The use of a modulus of rupture determined by experiment on a special form of beam is not based on any satisfactory principle. The employment of this modulus is an imperfect means of correcting a defective theory. A different value is found for f when bars of different sizes or cross sections are tested. Even the same bar broken in different ways will give a sensibly different value for f. The use of this modulus is, however, convenient when great accuracy is not required.

§ 16. *Expressions for the Bending Moment caused by Special Distributions of Load.*—From equation 1, § 14 it is easy to deduce the following values for the bending moments in beams subject to various simple distributions of load:—

Case 1. Let a single load W be placed at the centre of a beam; let M_x be the moment at any section taken at the distance x from the nearest pier; let M_c be the moment at the centre of the span, we have—

$$1. \quad \ldots\ldots \quad M_x = \tfrac{1}{2}Wx,$$

$$2. \quad \ldots\ldots \quad M_c = \tfrac{1}{4}Wl.$$

M_c is the maximum moment at any section of the beam.

Case 2. Let a single load W be placed at the distance x_1 from the nearest pier; let M_{x_1} be the moment at the section where the load is applied—

$$3. \quad \ldots\ldots \quad M_{x_1} = W\frac{lx_1 - x_1^2}{l}.$$

M_{x_1} is the greatest moment which the load at that place produces at any part of the beam, and increases as the load rolls from the end to the centre in proportion to the product $(l - x_1)\,x_1$ of the parts into which the load divides the beam.

Case 3. Let the load be uniformly distributed along the beam so that each unit of length bears an equal load $w = \frac{W}{l}$; when the unit of length adopted is the foot, the quantity w is called the *load per foot run.* Let M_c and M_x be as before the moments at the centre of span, and at any distance x from the nearest pier, we have—

$$4. \quad \ldots\ldots \quad M_c = \tfrac{1}{8}wl^2,$$

$$5. \quad \ldots\ldots \quad M_x = \tfrac{1}{2}w\,x(l - x).$$

When a uniform passing load, such as is approximately represented by a train of locomotives, of length at least equal to the span of the bridge, comes on to a bridge at one end and passes over to the other, gradually covering the whole span, the bending moment reaches a maximum for all sections when the bridge is wholly covered. The bending moment at any section for a combination of loads is the sum of the moments at that section due to each load taken separately. When many different distributions of load have to be provided for engineers are in the habit of representing the bending moment for each load by a line, the ordinates of which are the bending moments at the sections, and the abscissæ the distances of the several sections from one point of support. The lines having been drawn for the several loads, it is easy by superposition to find the bending moment due to the combination, and thus to pick out for each section of the girder the maximum bending moment which any combination gives. Figs. 15, 15*a*, 15*b*, and 15*c* show diagrams giving the curve of bending moments for some simple distributions.

Fig. 15 shows the line of bending moments when a single

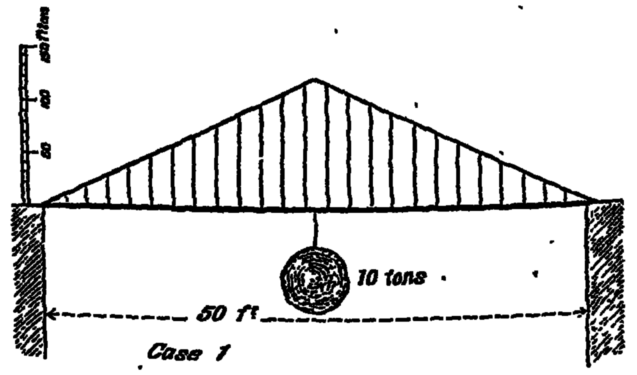


Fig. 15.

load of 10 tons hangs at the centre of a span of 50 feet. The vertical ordinates measured on the vertical scale give the bending moments at each section. Fig. 15*a* shows the curve of bending moments for a uniformly distributed load

of 1 ton per foot run on a span of 50 feet. The upper curve in fig. 15b shows the curve of bending moments

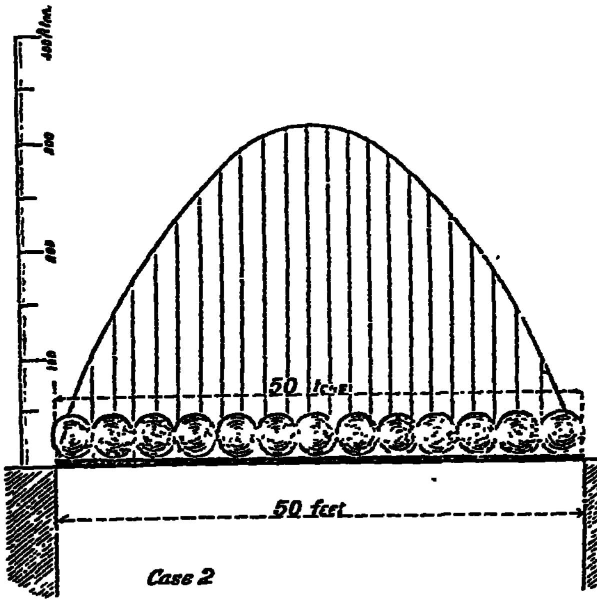


Fig. 15a.

when the loads of case 1 and 2 both occur at once. This curve is obtained by adding the ordinates in case 1 to those in case 2. Fig. 15c shows the four separate lines of

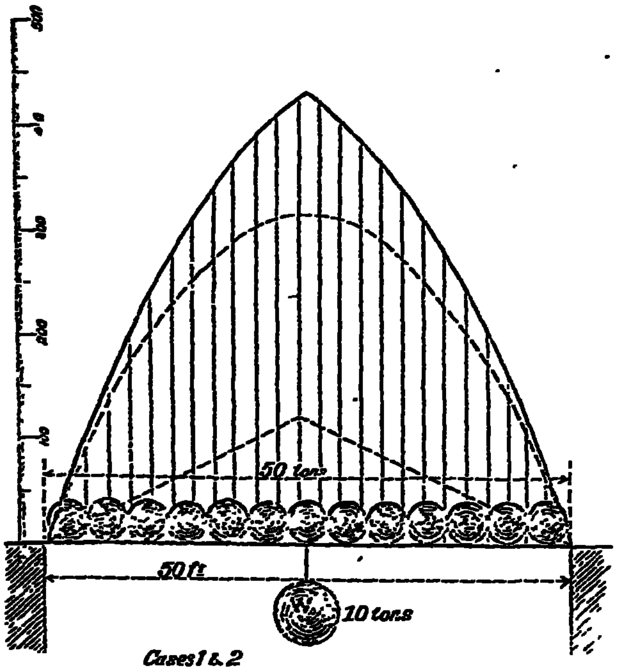


Fig. 15b.

bending moment for four separate weights, and the broken upper line is the line of bending moments for the case when the four loads all rest at once on the beam; it is got by simply adding at each point of the span the four ordinates due to the four loads considered separately. The curve in fig. 15a and the curve ABCD in fig. 15c are parabolas.

The bending moment at any section is reckoned as *positive* when the external forces on the beam tend to turn the right hand side of the beam in a left-handed direction (or in the direction opposite to that followed by the hands of a watch), in other words, when the bending moment tends to bend the beam downwards between the supports. We shall hereafter see that in beams with more than two supports the bending moment is at places *negative*, tending to bend the beam up; the curve of bending moments is drawn below the datum line where the moments are negative. Fig. 25a gives an example of a curve of bending moments of this class.

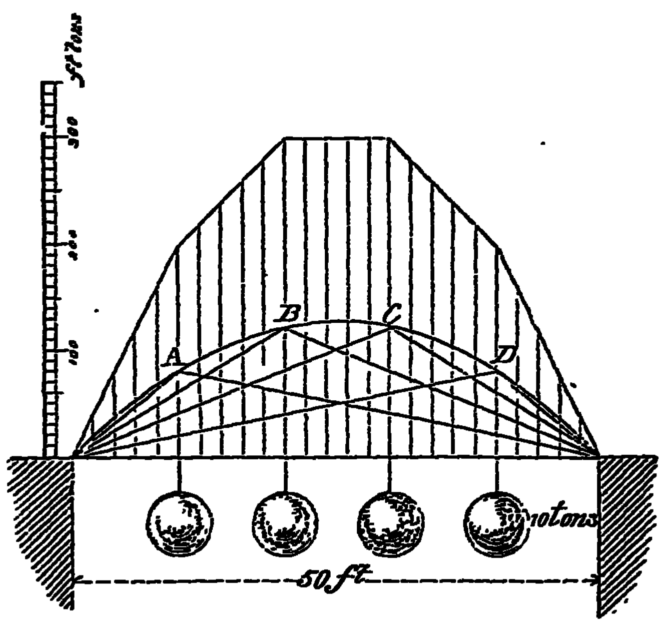


Fig. 15c.

§ 17. *Moment of Elastic Forces.*—On the hypothesis above stated, viz., that for any one material the modulus of elasticity may be taken as constant for all stresses, and assuming that our investigation is to be confined to those cases in which the cross section of the beam has a vertical axis of symmetry, and in which the centre of gravity lies at a point equidistant from the top and bottom of the beam, the general equation—

$$\mu = a\mathrm{I} = 2\frac{p_1\mathrm{I}}{d},$$

(3, § 14), allows simple expressions of the value of μ to by obtained for all practical cases by substituting for the ratio $\frac{2\mathrm{I}}{d}$ its value in terms of the dimensions of the cross section. Thus, for a rectangle of the depth d and breadth b,

$$\frac{2\mathrm{I}}{d} = 2\frac{bd^3}{12d} = \frac{bd^2}{6} = \frac{\mathrm{S}d}{6},$$

where S is the area of the cross section. The following are the values for the commonest forms of cross sections.

TABLE IX.—*Values of* $\frac{2\mathrm{I}}{d}$ *for various Cross Sections.*

Form of Cross Section.	$\frac{2\mathrm{I}}{d}$ In Terms of Linear Dimensions of the Cross Section.	$\frac{2\mathrm{I}}{d}$ In Terms of the Area of the Cross Section (S) and the Depth.
Square, side b	$\frac{b^3}{6}$	$\frac{\mathrm{S}b}{6}$
Rectangle, breadth b depth d	$\frac{bd^2}{6}$	$\frac{\mathrm{S}d}{6}$
Circle, radius r	$\frac{\pi r^3}{4}$	$\frac{\mathrm{S}d}{8}$
Hollow circle, external radius r, internal r_1	$\frac{\pi(r^4 - r_1^4)}{4r}$	$\frac{\mathrm{S}d}{4}$ when r_1 differs little from r.
Hollow rectangle, internal depth d_1, breadth b_1	$\frac{bd^3 - b_1d_1^3}{6d}$	$\frac{\mathrm{S}d}{2}$ when moment of web is neglected, and S is taken as area of cross section of flanges only, and d_1 differs little from d.

Substituting the modulus of rupture f (Table VIII.), for p_1 in equation 3, § 14, we can from the above values of $\frac{2I}{d}$ calculate the ultimate strength of any given cross section to resist any given bending moment. Thus, if we wish to know what breadth we must give a bar of wrought iron 3 inches deep, supported at points 3 feet apart, so that it may break with 2000 lb at the centre, we find the maximum bending moment from equation 2, § 16; and we find the value of μ from equation 3, § 14, by the help of table IX. Then equating M and μ, we have—

1. . . . . . $\frac{1}{4}WL = \frac{1}{6}fbd^2$,

from which $b = \frac{6WL}{4d^2f} = \frac{6 \times 2000 \times 36}{4 \times 9 \times 42000} = \cdot 286$.

Since the strength of the beam is directly proportional to the values of $\frac{2I}{d}$, table IX. shows us how to dispose of the material in the cross section so as to obtain the maximum strength. The expression for a rectangle shows that the strength is proportional to the breadth of a beam, but to the square of its depth; and therefore, as appears in the second column, for the same quantity of material the strength of a rectangular beam increases simply as the depth, so that a deep narrow beam is preferable to a square or to a broad and flat one. The circular cross section is weak compared even with the square (the ratio for the same quantity of material is ·846 to 1). The hollow tube is stronger than the thin rectangular plate of the same depth and *cross section*, but clearly the material is much best applied when wholly used in the form of two thin flat plates, separated from one another by a web of the maximum depth d which can be practically allowed. Thus the hollow rectangle is the form preferred for large girders, the material intended to resist the bending moment being placed in the top and bottom members of the girder, and kept apart by vertical webs, which add somewhat to the moment μ, but which are chiefly employed to resist shearing stress, as will be presently shown.

The I section, fig. 16, is that employed for small girders; the moment of its elastic forces is exactly the same as that of a hollow rectangle, having the same values for b, d, and d_1, and having a value for b_1 equal to $2b_2$ in fig. 16 It is usual to neglect the strength to resist bending moment given by the vertical web, and to design the girder so that the top and bottom plates are alone sufficient to meet this stress.

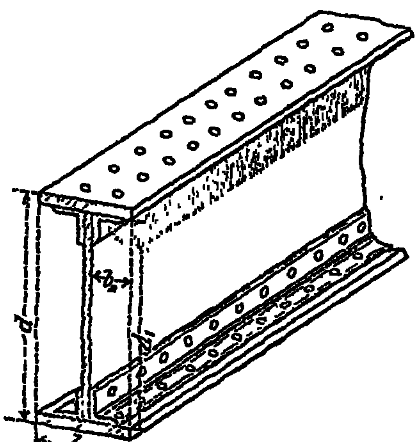


Fig. 16.

The model, fig. 10, shows at once that to obtain the full resistance from the material employed to resist tension or compression consistently with a given depth, it must all be placed in two horizontal plates at the extreme top and bottom of the beam; moreover, if $\frac{1}{2}$S is the sectional area of the top or bottom member, and f is the stress it will bear (assumed equal for tension and compression), the maximum moment which the elastic forces can exert is the sum of the moments due to the top and bottom members about the axis or tongue, *i.e.*, $2(\frac{1}{2}f\mathrm{S} \times \frac{1}{2}d)$ or $\frac{1}{2}f\mathrm{S}d$; or dismissing the idea of an axis through the centre of gravity of the section, we may (to refer again to the illustrative model) take the moment of the elastic forces round the line running through the top row of india-rubber pieces looked upon as a fulcrum, and then the moment of the bottom row will be as before $\frac{1}{2}f_t\mathrm{S}d$, and will be the *whole moment* of the elastic forces. Similarly, by taking the bottom row as the fulcrum, we see that the moment due to the top row will be the same. This moment calculated in either way is the *whole* moment of the elastic forces. This latter mode of considering the moment in the simple case of an I or hollow rectangle, enables us to find the value of the moment of elastic forces for those cases in which the ultimate strength may not be the same for tension and compression. Thus, assume that the strength of wrought iron to resist tension, or f_t, is 25 tons, and its strength to resist compression, or f_c, is 20 tons, then calling S_t the area of the bottom member at the section considered, and S_c the area of the top member, we have for μ the two values 25 S_td and 20 S_cd; whichever happens to be the smaller will represent the available value of the moment of the elastic forces. Consequently we must, in order not to waste material, design the beam so that the ratio of the material in the upper member to that in the lower member shall be 5 to 4. That this ratio ought to be adopted is evident from the fact that the strength of the beam will be limited by that of the weaker member. No structure is perfectly designed unless it will when overstrained give way simultaneously in every part. The foregoing theory, the soundness of which is borne out by experiment, tacitly assumes that, although the strength differs, the modulus of elasticity is constant for tension and compression. For example, if the flanges are made with sections bearing to one another the proportion of 4 to 5, the neutral axis (neglecting the web) will, assuming E constant, be at a distance from the top or larger flange equal to $\frac{4}{9}$ths of the depth; then the intensity of stress varying directly as the distance from the neutral axis will for the two flanges be in the desired ratio of 4 to 5. Thus we see not only that the I, or hollow rectangle, has the advantage of being the best form for a girder, but that it allows us easily to arrange the material to the best advantage, even when its strengths to resist tension and compression are dissimilar. Values of the modulus of rupture given above are therefore not to be applied to this design of beam, but the values of f_t and f_c are to be taken from Tables I. and II. In the case of cast-iron the member under tension is made with six times the cross section of the member under compression, the reason being the same as that for making the ratio of the upper and lower members of the wrought iron beam 5 to 4. When a cast-iron beam is thus designed, the moment which any section can exert will for a given depth be proportional to the area S_t of the lower flange. Professor Hodgkinson verified this theory experimentally, and found that the ultimate value of the moment due to elastic forces expressed in lbs and inches for beams thus designed was $\mu = 16500\ \mathrm{S}_td$. The value of the constant agrees closely with the tensile strength of cast-iron. The experiments by Professor Hodgkinson are therefore consistent with the assumption, that although the strength of cast-iron is very different in resisting tension and compression, nevertheless the modulus of

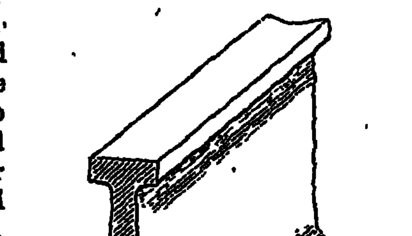


Fig. 17.

elasticity is equal under the two kinds of stress. Fig. 17 shows the cross section usually adopted for cast-iron girders.

§ 18. *Neutral Axis.*—The line ZZ_1, fig. 14, perpendicular to the plane in which a beam is bent, and passing through the centre of gravity of any given cross section, is called the *neutral axis* of the beam at that point. The surface containing all the neutral axes is the *neutral surface.* Practical engineers sometimes apply the term neutral axis to the longitudinal line showing the neutral surface on a side elevation, but in this article, as in Rankine's works, the words will be used as defined above.

When the assumption is made that the modulus of elasticity is the same for any given material whether under tension or compression, notwithstanding any difference in the ultimate strength to resist tension or compression, then it follows, as has been shown, that the neutral surface of a bent beam will separate it into two parts, one of which is compressed while the other is extended. The neutral axis in any cross section then contains the only part of the material which is neither extended nor compressed.

If, however, the average value of E for stresses varying between zero and the maximum intensity of compression to which the beam is subjected be different from the average value between zero and the maximum intensity of tension, then the neutral axis as above defined will not be the *unstrained* axis; the neutral axis is determined as soon as the cross section of the beam is known, being independent of the material used; the unstrained axis may differ in beams of the same cross section but made of different materials; for if the average of E be greater say for compression than for tension, this will raise the unstrained axis above the neutral axis. It is not improbable that the position of the unstrained axis may vary in the same beam with loads similarly distributed, but of different magnitude, and also with different distributions of load. Until experiments shall have accurately determined the relation of E to the intensity of stress we have no means of determining accurately the position of the unstrained axis. Even when E is constant the neutral axis, as above defined, will not always in practice correspond with the unstrained axis; for instance, in a beam which was not only bent across, but also compressed endways, the unstrained surface would no longer contain the neutral axis as above defined. The unstrained surface might be near one edge of the beam, or, indeed, if the general compression were large and the bending small, the whole beam might be under compression, so that no part was unstrained. By restricting the use of the words neutral axis to the above definition, and using the words unstrained axis, or unstrained surface, for the second idea all ambiguity will be avoided.

The actual position of the unstrained axis in any beam of any material subject to a bending moment depends on the relative values of the modulus of elasticity for the material under all stresses positive and negative, great and small; but as the simple hypothesis of a constant modulus is borne out by experiment in the most important materials, it is unnecessary to pursue this subject further.

§ 19. *Shearing Stress.*—The theory hitherto given shows the relation between longitudinal stresses (such as are resisted by the india-rubber in the model) and the load on the girder; but in designing a girder we have also to provide for the shearing stress or transverse force tending at each imaginary cross section to make the more heavily loaded of the two parts into which it divides the bridge slide down past the other. This shearing stress was resisted by the tongues of the model. The total shearing stress at any section is the sum of all the vertical forces acting on the beam on one side of the section. The shearing stress at any section will be called positive if the sum of the external forces on the right hand part of the beam tends to lift that portion up. Diagrams may be conveniently used to show shearing stresses, and, as in the case of bending moments, the shearing stress at any section due to two or more loads is simply the algebraic sum of the shearing stresses due to each load.

Example 1. Load W at centre between supports (fig. 18); weight of beam neglected. The shearing stress is

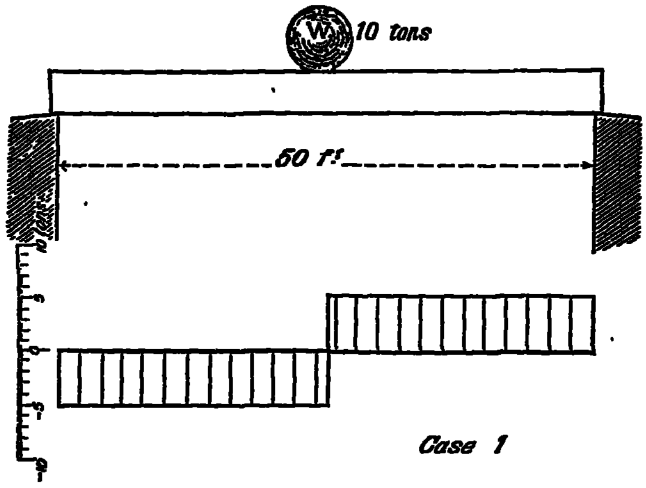


Fig. 18.

equal to $\frac{1}{2}W$ all along the beam, being the reaction at one pier; the stress is positive to the right of the load, negative to the left.

Example 2. Uniformly distributed load w per foot run (fig. 18a). The shearing stress is $\frac{1}{2}wL$ at the points of

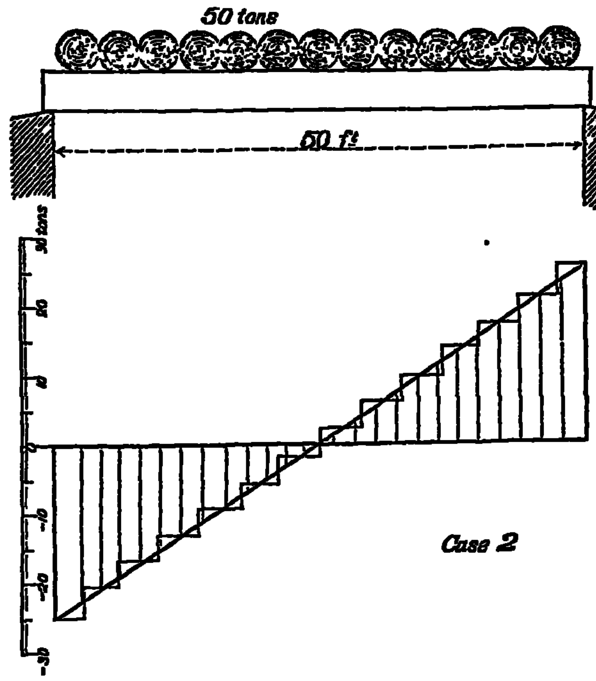


Fig. 18a.

support, and zero at the centre of the span; at any section distant c from the centre of the beam it is wc.

Example 3. A single load rolling from right to left of a beam of span L (fig. 18b). When the load is at the distance x from the right hand support the shearing stress to the right of the load is $W\frac{L-x}{L}$, and to the left it is $-\frac{Wx}{L}$. The maximum stress for each section occurs when the load reaches that section; it is positive for the right half, and negative for the left half of the beam.

Example 4. Uniform advancing load of w per unit of length

(fig. 18c). When the load covers a length x measured from the right hand pier, the shearing stress at all points beyond x towards the left is $-\frac{wx^2}{2L}$; when x is greater than $\frac{1}{2}L$

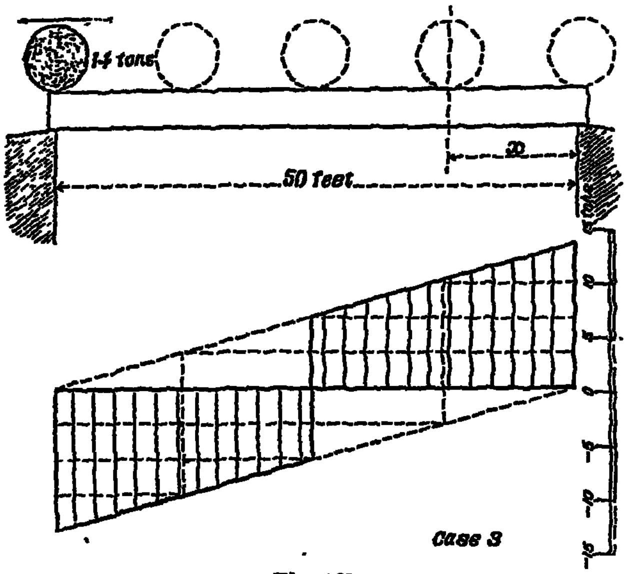


Fig. 18b

the above expression gives the maximum stress which can occur on that section with any distribution of the given uniform load. Thus the maximum shearing stress at the left end occurs when the whole bridge is loaded, and is $-\frac{1}{2}wL$; the maximum stress at the centre occurs when the bridge is half loaded, and is equal to $-\frac{1}{8}wL$. The maximum shearing stresses on the other half of the beam occur when the load comes on from the left side, and covers more than half of the beam; these stresses are equal in amount to the stresses in the left half, but are positive in sign.

The scales in figures 18, 18*a*, correspond to the shearing stresses in examples 1 and 2 for a span of 50 feet and loads of 10 tons and 1 ton per foot run respectively. The scale in fig. 18*b* corresponds to the shearing stresses in example 3 with a single passing load of 14 tons. The scale in fig. 18c, example 4, gives the maximum shearing stress which the advancing load of one ton per foot run can produce at each section. As a train leaves a bridge it produces the same shearing stresses as when it comes on to the bridge from the opposite end, the same portions being similarly loaded. The maximum shearing stress due to a passing load of this kind changes its sign at the centre of the span, as appears by diagram 18c.

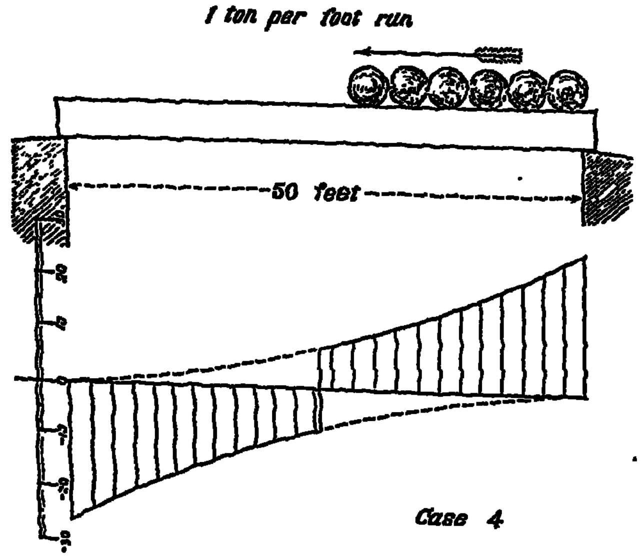


Fig. 18c.

In I girders with solid vertical webs the shearing stress is practically all borne by the web unassisted by the top or bottom members, it being clear that these would fold down at the sides under a small fraction of the total stress. Sufficient material is therefore employed in the web or upright plates to reduce the intensity of the stress to the desired amount. The shearing stress may, however, when the web is a thin iron plate, cause failure by crumpling the web, or causing it to buckle, instead of by shearing it across. This tendency is prevented by stiffening the web with angle or T irons rivetted to the sides. Mathematical analysis has not yet been very successfully applied to the determination of the amount of stiffening required; experience has given a sufficient number of examples to guide the practical designer. In cast-iron girders the web is generally much in excess of the strength required to resist shearing.

§ 20. *Factor of Safety.*—In designing a girder the load which it will have to carry is multiplied by a number called the factor of safety, varying from 3 to 6, and the girder is so designed that it shall not yield at any point with less than the load thus multiplied. If, for instance, the girder is practically to carry 1 ton per foot run, it is designed so that at no place shall it *break or yield injuriously* with less than say 5 tons per foot run. The multiplier is called the *factor of safety*. The factor of safety is required to allow for imperfections in the material as compared with picked specimens, for the wear and tear by which the strength of a structure is gradually reduced, for unforeseen loads, for jars and vibrations, for imperfection of theory, and for the sake of obtaining stiffness. This last property might be the subject of calculation, and in some cases must be separately examined. The particular factor employed depends on the judgment of the engineer. A larger factor of safety is required for a passing or moving load than for a permanent load, there being a greater uncertainty as to the stress which may be caused by vibrations or impulses due to what is sometimes called a live load. Moreover, the mere presence of a large permanent load tends by its inertia to diminish the dangerous effect of the impulses or stresses due to the passing load, so that the factor of safety should be chosen with reference to the ratio $\frac{\text{max. passing load}}{\text{max. permanent load}}$ being larger as this ratio increases. Rankine recommends that the factor of safety should for the moving load be double that employed for the permanent load. Sometimes the factor is more conveniently employed as a divisor to deduce the safe stress f_1 from the ultimate strength f of the material, rather than as a multiplier for the load. Thus the same number of square inches will be obtained in the tension member of a wrought iron girder to bear 1 ton per foot run, whether we use in the calculations 25 tons as the value of f, the ultimate strength of the material, and a load w of 5 tons per foot run, or if we use 5 tons as f_1, the safe stress on the material, and a load w of 1 ton per foot run; in short, if we call the factor of safety K, we may in equation 5, § 14, use $KM = \frac{2fI}{d}$, or making $f_1 = \frac{f}{K}$, we may write

$$1. \quad \ldots \quad M = \frac{2f_1 I}{d}.$$

The same remark applies, of course, to equation 6, § 14.

§ 21. *Weight of Girders and Roadway.*—When two girders are employed for each line of way on a railway, the weight of the iron girders per foot run will, with the usual proportions, probably lie between 0·0017L tons and 0·0025L tons, L being the span in feet. It follows from the theory given above, that for similar beams the quantity of material in the whole girder will be proportional to the square of the length, and, therefore, the quantity per foot run will be proportional to the

simple length. The constants given above are derived from practice. The weight of girders for a common road, if placed from 7 to 8 feet apart, will be nearly the same as for railway girders of the same span. The weight of a cast-iron railway girder (two girders per way) will be about 0·005L tons per foot run. The weight of the *roadway* in a railway bridge will probably be from 0·14 to 0·22 tons per girder, or double this for each line. For a turnpike road with metalling the weight will much exceed this, and should in each case be computed.

§ 22. *Design of a Girder.*—(1.) From the span and load to be carried the engineer will determine the material and form to be employed. Cast-iron may in some districts be the cheapest material for girders under 30 feet span. Wrought iron I girders are very generally employed for spans of from 30 feet to 100 feet; beyond that span lattice or framed girders are more usually employed. For extreme spans exceeding, say, 300 feet, a hollow rectangle or tubular bridge may be used, carrying the road on its top or inside the tube. The depth of the cross section is limited by the consideration that the web must be sufficiently stiff not to buckle; but for this consideration the deeper a girder could be made the better. In practice the depth is made from $\frac{1}{8}$th to $\frac{1}{15}$th of the span. The engineer will also determine whether he will keep the depth of the girder constant throughout or diminish the depth at the ends. It is impossible to graduate the material so as to give absolutely uniform strength at all sections, but by diminishing the depth towards the ends, some material may be saved without attenuating the top and bottom members to such an extent as to be inconvenient. When the general character of the design has thus been settled, the engineer will compute the probable weight of the girders and roadway or total permanent load; he will next determine the passing load for which he intends to provide.

(2.) The value of M, the bending moment, must next be computed for a sufficient number of cross sections of the beam, and for various distributions of load. For a small cast-iron girder of uniform cross section a single value of M will be sufficient, computed for the section at the centre when the girder is wholly covered with the greatest uniform load and also supports the greatest single load at the centre of the span. When, as in larger girders, the design is intended to give a structure of approximately equal strength throughout, the maximum value of M should be found for eight or ten sections; this maximum value will be that obtained when the bridge is wholly loaded with its maximum uniform load and has the maximum single load resting just over the section in question.

(3.) The maximum shearing stress must next be calculated for each of the above sections. The designer will bear in mind that the maximum stress occurs at the points of support, and that at the centre it is greatest when the bridge is half covered with the passing load.

(4.) The engineer can now compute the number of square inches S_c and S_t required at each section in the upper and lower members consistently with the factor of safety he chooses to employ; this he obtains from the expressions—

$$1. \quad . \ . \ . \ . \ . \ . \ . \quad S_t = \frac{M}{f_1 d},$$

$$2 \quad . \ . \ . \ . \ . \ . \quad S_c = \frac{M}{f_2 d}.$$

It is here assumed that the best and strongest form of girder is employed, but if a mere square or circular beam is to be used, the cross section will be obtained by equating the values of M and μ, using a safe modulus of rupture f_1.

(5.) The web will next be designed by giving it such a thickness as will, with the depth already fixed, supply the number of square inches required to reduce the stress per square inch to the *safe* or *proof* shearing stress, say 4 or 5 tons on wrought iron. When the web is a thin wrought iron plate it must be stiffened with ⊥ or angle irons. In a cast-iron girder the web must have at least the number of square inches required by the shearing stress, but the exigencies of the foundry generally require a design resulting in a great excess of strength in this part of the beam, except in beams which are tapered towards the ends, as in fig. 19. With these beams care must be taken that

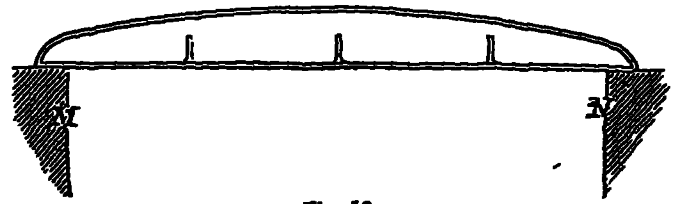


Fig. 19.

the taper is not carried to excess so as to leave insufficient metal to resist the shearing stress at M and N.

§ 23. *Practical Details.*—The designer must be practically acquainted with the forms in which his materials can be best procured. He must know the sizes in which iron or steel plates can be produced, and the forms best adapted for castings. Thus, in cast-iron beams the thickness of the web is at the bottom made equal to the thickness of the lower flange, and at the top to the thickness of the upper flange, in order to avoid permanent internal strains, which would result from unequal rates of cooling after being cast, if sudden changes of thickness in the metal were allowed. The engineer must also be familiar with the methods adopted of joining the several parts, as with the rivetting of wrought iron, the bolting together of large castings, the jointing of wood-work. He should also be acquainted with the various methods in which roadways are constructed and supported on existing bridges, and the manner in which the girders are braced one to another, so as to prevent vibration and lateral deflection due to the pressure of the wind. The examples of bridges described hereafter will give some information on these points. In long girders provision must be made by rollers, sliding plates, or suspension links for the expansion and contraction due to changes of temperature. The range in Great Britain may be taken as about 45° C. If the ends of the girder could be firmly secured at a constant distance apart this change of temperature would produce a stress of about 6 tons per square inch in wrought iron, and 3 tons per square inch in cast-iron. The result in practice would be that any attempted fastening of stone or iron work would be torn loose.

§ 24. *Deflection.*—When a bridge has been erected its deflection at the centre under a known passing load is generally observed with the object of ascertaining whether the work has been properly done, for it is assumed that any defective material or bad jointing would increase the deflection beyond that calculated on the assumption of sound material and perfect workmanship. Sometimes the practical test applied is a rough one, a certain fraction of an inch being allowed per foot of span as a safe deflection. If an inspector of bridges, having authority, chooses to limit the deflection to a constant fraction of the span, the ratio of the depth to the span must be made sufficiently great to give the desired stiffness and maintained constant for all spans; equation 5 below shows that when p_1 is kept constant and d is a given fraction of L, the deflection v will be proportional to the span. For the proof or maximum possible load, Rankine gives as the result of practice a value for the deflection of from $\frac{1}{200}$L to $\frac{1}{600}$L; but one foot deflection in a span of 200 feet would certainly be exces-

sive. A depth equal to or greater than $\frac{1}{12}$th of the span is certain to give sufficient stiffness, and the usual method is to assume the depth and then to observe whether experiment gives a deflection agreeing with that found by calculation. The calculation is made by finding the radius of curvature of the beam at a series of sections, and then determining the curve assumed by the whole beam either by integration or by an approximate graphic method. When the curve is known the deflection or versed sine is found either from the equations of the curve, or by actual measurement on the diagram to be presently described. Let R be the radius of curvature of the neutral surface of a beam at a given section, under a load producing a maximum stress p_1 at the outer elements of the section at a distance y_1 from the neutral surface. Consider a short length x of the beam fig. 20. Before deflection the length of the

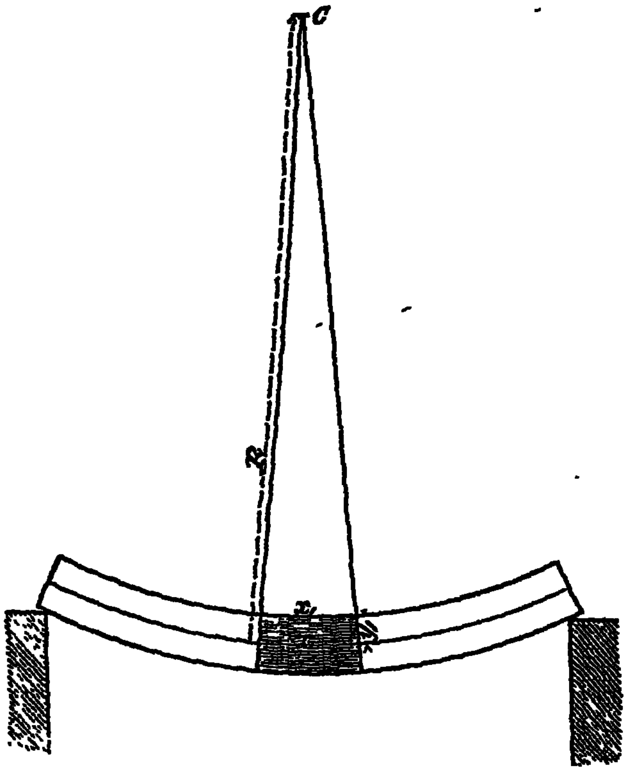


Fig. 20.

outer element is equal to x, but after deflection (if we consider the upper member) the length of the outer element will be shortened to x_1, while the length of the element in the neutral surface remains equal to x. By similar triangles we have $x : x_1 = \mathrm{R} : \mathrm{R} - y_1$, or $\mathrm{R} = \frac{y_1 x}{x - x_1}$, but $x - x_1$ is the extent to which the most compressed element is shortened, and by the definition of the modulus of elasticity we have $\mathrm{E} = p_1 \frac{x}{x - x_1}$, hence

$$1. \quad . \quad . \quad . \quad . \quad . \quad . \quad \mathrm{R} = \frac{\mathrm{E}y_1}{p_1},$$

from which the radius of curvature at any section can be obtained in terms of E, y_1, and p_1, all known quantities with a given cross section, material, and load. Another form of the same expression, which is sometimes more convenient, is obtained by remembering that $\mathrm{M}_1 = \frac{p_1 \mathrm{I}}{y_1}$, hence

$$2. \quad . \quad . \quad . \quad . \quad . \quad . \quad \mathrm{R} = \frac{\mathrm{EI}}{\mathrm{M}_1},$$

where M is the bending moment which will produce p_1. If p_1 is made equal to f_1 the maximum safe stress on the material, equation 1 or 2 gives the minimum safe radius of curvature.

We will first consider the special case in which the beam under consideration is of *equal depth and uniform strength* at all cross sections, and which we will call a beam of class 1; these conditions can only be fulfilled by any one beam for a given constant distribution of load; the beam of uniform strength for a load at the centre, for instance, will clearly not be the beam of uniform strength for a uniformly distributed load. In beams of class 1 for a given load, both y_1 and p_1 are constant, and therefore R, by equation 1, will also be constant throughout the whole length of the beam, or, in other words, the beam will bend into a circular arc. The approximate expression for the versed sine of an arc having a chord L and radius R will therefore give the deflection, and we have

$$3. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad v = \frac{\mathrm{L}^2}{8\mathrm{R}},$$

and employing for R the value given by equation 1, we have

$$4. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad v = \frac{\mathrm{L}^2 p_1}{8\mathrm{E}y_1}$$

and if $y_1 = \frac{1}{2}d$, we have

$$5. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad v = \frac{\mathrm{L}^2 p_1}{4\mathrm{E}d}.$$

If for p_1 we substitute f_1, the maximum safe stress for the given materials, equation 4 or 5 will give the maximum safe deflection, which may be called v_1; we observe, then, that the safe deflection for a beam of this class will be proportional to the square of the span, and inversely proportional to the depth of the beam.

In beams of class 1, the deflections which different loads produce will be simply proportional to the values of p_1 produced by those loads; thus, for a given distribution of load, the deflection will be simply proportional to the load; if we change the distribution of the load, keeping the total load constant, the same rule will give the solution; for instance, since a load uniformly distributed produces only half the stress p_1 which would be produced by the same load at the centre of a beam of the same span and cross section, we see that the uniformly distributed load will produce only half the deflection that would be produced by the same load at the centre of a beam of the same span and same *section at the centre* (both beams belonging to class 1). It would *not* be correct to say that a load uniformly distributed would produce half the deflection produced by the same load at the centre of the *same beam*, because the same beam cannot be uniformly strong throughout its length for two different distributions of load.

We may compare the deflections produced by the same load on various beams of similar cross section as follows:—By equation 4, § 14, we see that for a given moment M, p_1 is proportional to $\frac{d}{\mathrm{I}}$; moreover, for equal loads, the moment M at any cross section similarly placed will be proportional to L; hence we may write

$$p_1 \propto \frac{\mathrm{L}d}{\mathrm{I}} \propto \frac{\mathrm{L}}{bd^2}.$$

Substituting this expression for p_1 in equation 5, we have

$$6. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad v \propto \frac{\mathrm{L}^3}{bd^3},$$

an equation which expresses the fact that, for beams of class 1, the deflection produced by a given total load similarly applied will be proportional to the cube of the length, and inversely proportional to the breadth and to the cube of the depth. (In I girders the expression breadth must be understood as proportional to S, the section of the flange.)

Passing from beams of class 1 to beams in general, the

fundamental difference to be observed will be that the curve assumed by the neutral surface will not be that of a circular arc, so that equation 1 is no longer true. Where, however, the law according to which R varies can be stated algebraically, integration will give the value of v.

Combining equations 2 and 3 for class 1, we have $v = \frac{1}{8}\frac{M_1L^2}{EI}$, and as $M_1 \propto LW$, we have $v \propto \frac{WL^3}{EI}$. Now this proportional equation can be shown to hold good for beams of uniform cross section and uniform depth, which may be called beams of class 2, also for beams of uniform cross section and uniform breadth, which may be called beams of class 3, hence for the three classes of beams we may write

$$7. \quad . \quad . \quad . \quad . \quad . \quad . \quad v = n\frac{WL^3}{IE},$$

where n will have different values in the three classes and for each distribution of load.

Similarly it can be proved, that where beams are so designed that the loads produce the same maximum value p_1 of the stress on the outer elements, we have the deflection proportional to $\frac{p_1L^2}{Ey_1}$,—equation 4 being one case of the general law; we may therefore write

$$8. \quad . \quad . \quad . \quad . \quad . \quad . \quad v = n_1\frac{p_1L^2}{Ey_1},$$

where n_1 is a constant differing for each class of beam and each distribution of load.

Table X. gives the values of n and n_1 for the three classes of beam, and for two distributions of load. The value of p_1 in the case of a beam of uniform cross section applies to the stress at the centre; the stresses elsewhere in that beam will be less.

TABLE X.—*Values of* n *and* n_1.

Description of Beam.	W at Centre.		W uniformly distributed.	
	n	n_1	n	n_1
Uniform strength and depth..	$\frac{1}{32}$	$\frac{1}{8}$	$\frac{1}{64}$	$\frac{1}{8}$
Uniform strength and breadth	$\frac{1}{24}$	$\frac{1}{6}$	0·0178	0·1427
Uniform cross section..........	$\frac{1}{48}$	$\frac{1}{12}$	$\frac{5}{384}$	$\frac{5}{48}$

In any actual bridge girder the deflection should lie between the value calculated for the beam of uniform strength and that calculated for the beam of uniform cross section.

§ 25. *Graphic Method of finding Deflection.*—Divide the span into any convenient number n of equal parts of length l, so that $nl = L$; compute the radii of curvature R_1, R_2, R_3 for the several sections. Let measurements along the beam be represented according to any convenient scale, so that calling L_1 and l_1 the lengths to be drawn on paper, we have $L = aL_1$; now let r_1, r_2, r_3 be a series of radii such that $r_1 = \frac{R}{ab}$, $r_2 = \frac{R_2}{ab}$, &c., where b is any convenient constant chosen of such magnitude as will allow arcs with the radii r_1, r_2, &c., to be drawn with the means at the draughtsman's disposal. Draw a curve as shown in fig. 21 with arcs of the length l_1, l_2, l_3, &c., and with the radii r_1, r_2, &c. (note, for a length $\frac{1}{2}l_1$ at each end the radius will be infinite, and the curve must end with a straight line tangent to the last arc), then let v be the measured deflection of this curve from the straight line, and V the actual deflection of the bridge; we have $V = \frac{av}{b}$, approximately. This method distorts the curve, so that vertical ordinates of the curve are drawn to a scale b times greater than that of the horizontal ordinates. Thus if the horizontal scale be one-tenth of an inch to the foot, $a = 120$, and a beam 100 feet in length would be drawn equal to 10 inches; then if the true radius at the centre were 10,000 feet, this radius, if the curve

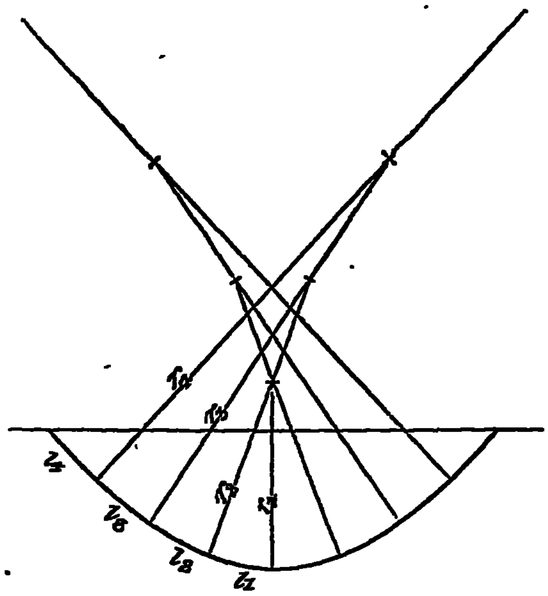


Fig. 21.

were undistorted, would be on paper 1000 inches, but making $b = 50$ we can draw the curve with a radius of 20 inches. If we now measure the versed sine of an arc drawn with a length 10 inches and a radius 20 inches, we shall approximately find it equal to 0·64 inches, hence $V = \frac{120 \times \cdot 64}{50} = 1{\cdot}54$ inches. The vertical distortion of the curve must not be so great that there is any very sensible difference between the length of the arc and its chord. This can be regulated by altering the value of b. In fig. 21 distortion is carried much too far; this figure is merely used as an illustration, and is not to be taken as an example.

§ 26. When a girder has more than two supports it is called a *continuous girder*. The distribution of the stresses in a continuous girder differs very materially from that in a simple girder, as will be at once apparent by the inspection of fig. 22, which shows the way in which a continuous

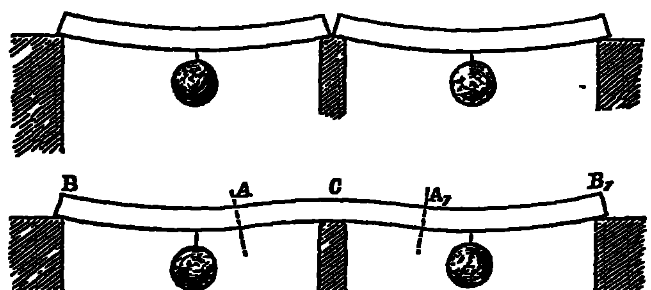


Fig. 22.

girder of two spans and two simple girders bend when employed to carry equal weights across equal openings. The continuous girder when both spans are loaded is bent upwards at C over the centre pier; in other words, the bending moment at this and neighbouring points is negative. The direction of the flexure changes at certain sections, as at A and A_1, *i.e.*, the bending moment is positive on one side of these sections, negative on the other side; and at the section where the direction of flexure changes the bending moment is *nil*. Again, when only one of two simple girders is loaded, the girder over the second span is not bent in either direction, but with the continuous girder there may be a negative bending moment produced throughout the whole unloaded span as shown in fig. 23. Con-

tinuous girders require less material for the same depth, span, and permanent load than simple girders; but the difference is hardly worth consideration, except in large

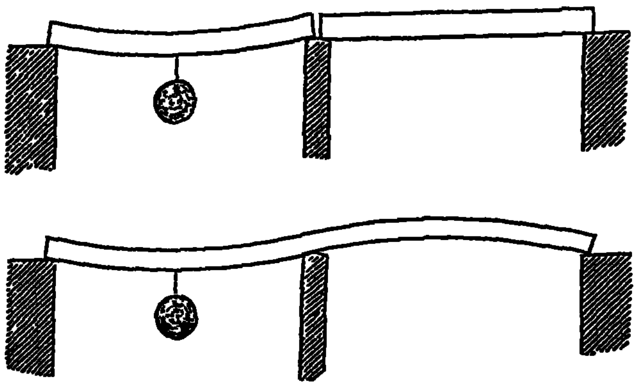


Fig. 23.

spans where the weight of the structure is great as compared with the weight of the passing load. The necessity of allowing the girder to expand and contract freely with changes of temperature limits the general use of large continuous girders to two spans.

Consider a continuous girder having an indefinite number of supports equally spaced; let the girder be of constant depth, uniformly loaded, and so proportioned as to be of uniform strength at all sections. The method of designing such a girder has not yet been shown, but it may be admitted that the design is possible. Then, as we have already seen (§ 24), the curvature assumed by the girder will everywhere be constant, *i.e.*, the curves will be circular arcs of constant radius. The points of inversion of flexure A and B (fig. 24) must therefore in this case

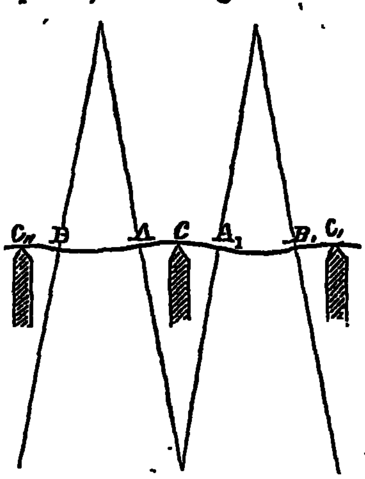


Fig. 24.

be at a distance from C and C_{11}, equal to one quarter of the span; for $AA_1 = AB = A_1 B_1$ &c., and C bisects AA_1. At B and B_1 there is no moment of flexure. The girder might here be cut through, and if the ends B and B_1 were pinned on to the rest of the girder by pins capable of bearing the shearing stress, nothing would be changed in the curvature of the girder nor in the distribution of stress. Quite similarly, we may suppose the ends B and B_1 of the portion $BACA_1B_1$ to rest directly on supports or piers introduced for the purpose, the rest of the imaginary girder being wholly removed. We shall then have (fig. 25) the curve assumed by a continuous girder of two spans of constant depth and uniform strength. The points AA_1 of inversion of flexure will be at a distance CA from the middle pier equal to one-

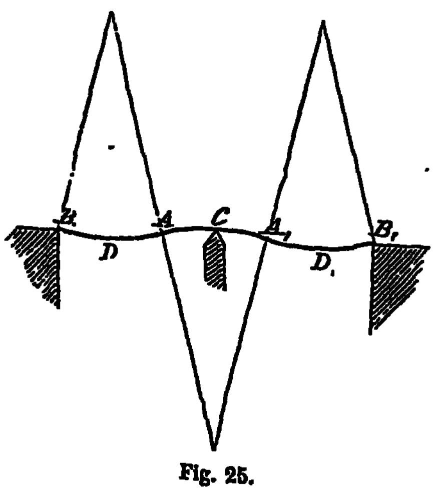


Fig. 25.

third of the span. The top and bottom members at A and A_1 might vanish (if only one distribution of load were to be carried), for at this point there is only a shearing stress and no bending moment. The girder is, as it were, made up of three girders: BA and A_1B_1 hang on to AA_1, which is supported in the middle; half the weight of AB is borne by the pier B; half the weight of A_1B_1 is borne by the pier B_1; the rest of the weight between B and B_1 is borne by the middle pier. Thus let L be the length of one span in feet, w the load per foot run, P the load borne by each of the end piers, and P_c the load borne by the centre pier, then we have—

1. . . . . $P = \frac{1}{3}wL$,
2. . . . . $P_c = \frac{4}{3}wL$.

The curve of bending moments can now be calculated for each girder precisely as for a simple girder; the moment at any section is equal to the sum of the moments of all the external forces on one side of the section; the beam between A and B will be subject to bending moments equal to those produced by a uniform load on a simple girder if the span BA be similarly loaded. Between A and A_1 the moments will be negative, *i.e.*, the left-handed moment produced by the downward action of all the weights to the left will exceed the right-handed moment produced by the upward reaction of the pier at B (or of the two piers B and C if the section considered lies to the right of C). The full black line in fig. 25*a* shows a curve of bending moments for this case.

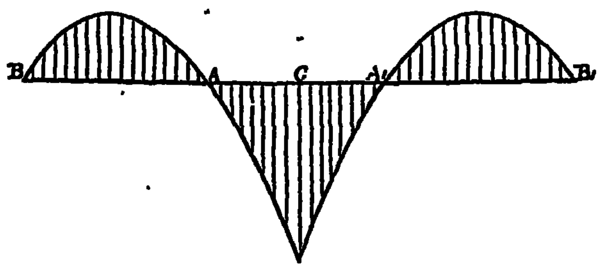


Fig. 25*a*.

The maximum moment is negative and occurs over the centre pier; let it be called M_c. The maximum positive moment occurs at a distance from B equal to one-third of the span; let this moment be M_d. Then we have—

3. . . . . . . $M_c = -\frac{1}{6}wL^2$,
4. . . . . . . $M_d = \frac{1}{18}wL^2$.

The shearing stresses F_b, F_d, F_a, F_c, at the points B, D, A, and C, are

5. . . . . . . $F_b = F_a = \frac{1}{3}wL$,
6. . . . . . . $F_d = 0$,
7. . . . . . . $F_c = \frac{2}{3}wL$.

Fig. 26 gives a diagram of the shearing stresses for two

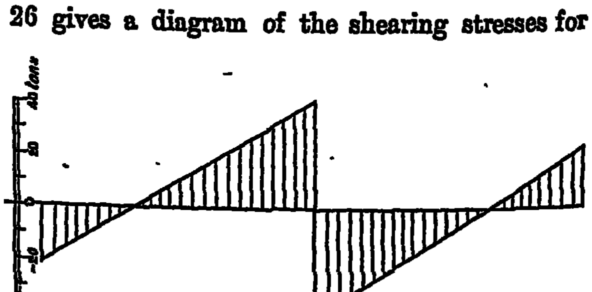


Fig. 26.

spans of 60 feet, with a uniform load of 1 ton per foot run.

When the beam is of uniform depth and uniform cross section, the curves in which it deflects are no longer circular; the defect of strength over the centre pier has

the effect of increasing the curvature over it, and shortening the distance AA_1; analysis shows that in this case the point of inversion of flexure will be at a distance from the centre pier equal to ·2683L; then the length of the part of the beam subject to a positive bending moment will be ·7317L, instead of ·66L as when the beam was of uniform strength; the load on each of the end piers will be ·36585wL; the load on the centre pier 1·2685wL; and we have—

8. . . . . $M_e = \cdot 1341wL^2$,

9. . . . . $M_d = \cdot 0669wL^2$,

10. . . . . $F_b = F_a = \cdot 36585wL$,

11. . . . . $F_d = 0$,

12. . . . . $F_c = \cdot 6341wL$

In any actual bridge uniformly loaded the values of the moments and shearing stresses will be intermediate between those given for a beam of uniform strength and those for a beam of uniform cross section. It must be observed that the above theory assumes that the girder is unstrained when being built as a whole; if, as is often the case, the separate spans are separately built and lifted into position, and then joined on the piers, special provision must be made to bring the desired bending moment over the piers into existence; it is obvious that merely joining the two independent beams in the upper part of fig. 22 will not make these into a continuous girder, such as is shown in the lower figure,—to do this, besides joining the upper and lower flanges, we must pull the top flanges together over the piers and put the lower flanges under compression. This may be done practically by tilting one end, or both ends, before the junction at the centre is made, and afterwards allowing the ends to sink until the curve assumed by the girder shows that the required distribution of stress has been attained. The complete analysis of the problem of continuous girders of any number of spans equal or unequal with any number of loads has been given by Mr Heppel (*Proc. R. S.*, 1870–71).

§ 27. *Allowance for Weight of Beam. Limiting Span.*—When the weight of the beam is a considerable and uncertain part of the whole load, it can be allowed for as follows. Design a beam of the desired depth and span, fit to carry a total load equal to the external or passing load W_1; calculate the weight of this beam and call it B_1; the beam so designed will really be fit to carry an external load $W_1 - B_1$. Let b_1 be the area of any cross section of this beam; let b be the area of cross section required at the same point for the beam of weight B actually necessary to carry a total load W. Then since the strength of the properly proportioned girder of constant depth and span is simply proportional to the quantity of metal employed, and therefore to the area of cross section, we have the proportion $b : b_1 = W_1 : W_1 - B_1$, or

1. . . . . . . $b = \dfrac{W_1 b_1}{W_1 - B_1}$.

The weight B is given by the expression—

2. . . . . . . $B = \dfrac{B_1 W_1}{W_1 - B_1}$.

The whole load W is given by the expression—

3. . . . . . . $W = \dfrac{W_1^2}{W_1 - B_1}$.

For any given design of beam there is a limiting length which cannot be exceeded (the beams of different spans being assumed to be *similar* in the geometrical sense). Let $L_{\prime}$ be the limiting length of a beam of a given design which for the span L weighs B, and carries a gross load W, then the ratio of B to W can be shown to increase in direct proportion to the length of the span until this ratio reaches unity. Hence—

$$\frac{B}{W} \cdot \frac{B_{\prime}}{W_{\prime}} = L : L_{\prime},$$

or when

$$\frac{B_{\prime}}{W} = 1,$$

4. . . . . $L_{\prime} = \dfrac{WL}{B}$.

III. Suspension Bridges.

§ 28. *Varieties of Suspension Bridges.*—A very simple form of suspension bridge has long been used in Peru and Thibet. Two ropes are hung side by side across the gorge to be passed, a rude platform is laid on the ropes, and the dip of these is sufficiently small to allow the bridge to be crossed by men or beasts passing down from the one side to the centre and up to the opposite bank. The modern suspension bridge consists of two or more *chains*, from which a level *platform* is hung by suspension *rods*. The chains may in some cases be secured directly to the sides of the chasm to be crossed, but the configuration of the ground seldom allows this to be done. The chains, therefore, usually pass over *piers*, as in fig. 2, Plate XIX., and are led down on either side to an *anchorage* at a considerable distance from the piers. The chains between the piers and the anchorage are generally used to support part of the platform. The chains where they pass over the piers rest on *saddles*, which are made of two different types. One construction, shown in fig. 27, allows the chain to slip backwards and

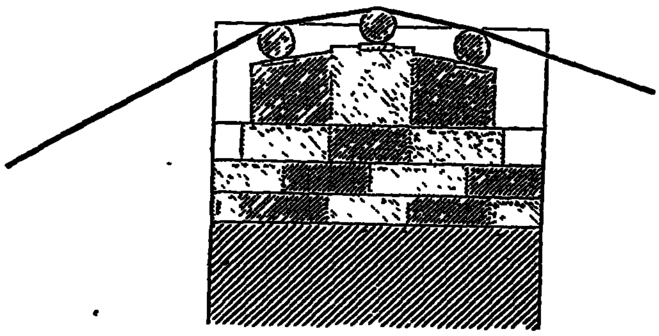


Fig. 27.

forwards over it with comparatively little friction, so that the stress on the rope may be taken as equal on both sides of the saddle. In the second type, as shown in fig. 28,

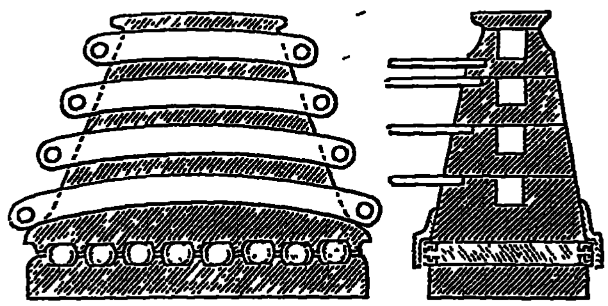


Fig. 28.

the chain is secured to the saddle, which, however, is free to move horizontally on the top of the pier. With the first form of saddle the resultant pressure on the pier will not be vertical unless the chain leaves the pier with an equal inclination on each side, and even when the bridge is designed with an equal slope of chain on both sides of the pier, a change in the distribution of weight due to any passing load will cause some departure from the equal slope of the chains, and therefore from the truly vertical pressure on the piers. This departure is easily allowed for in the design of the pier. The friction on the saddle renders the

assumption of equal stresses on each side slightly incorrect, and with this type of saddle care must be taken to provide against the wear produced by the motion of the chain. With the second type the use of rollers under the solid saddle leaves the motion of the saddle very free; the resultant pressure on the pier is always sensibly vertical, and the chains may leave the pier at any angle, equal or unequal. The chain must in no case be rigidly attached to the pier unless the support itself is free to rock on its base, as in fig. 29, where

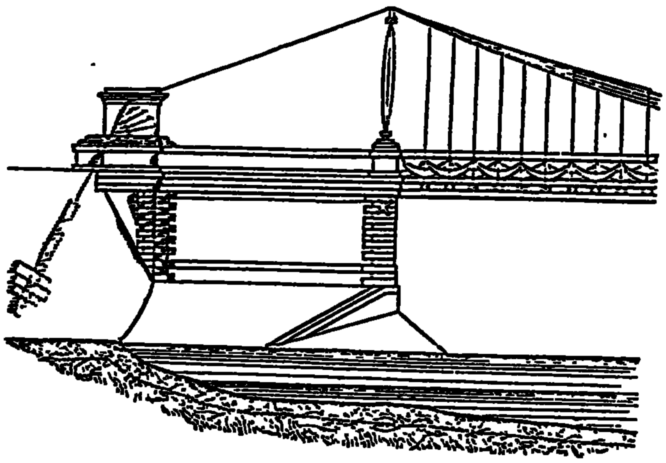


Fig. 29.

the place of the pier is taken by cast-iron struts, working on a horizontal axis.

Suspension bridges are chiefly used for very large spans, because, as we shall find, they can be constructed to carry the same load with a less weight of material than a beam or girder, subject, however, to the disadvantage of flexibility or deformation under a passing load,—a disadvantage which is very serious where, as in small bridges, the passing load is a large proportion of the whole load, but which is of less importance where the chief load to be carried is the weight of the structure itself. We will first consider the usual or simple suspension bridge, as shown in fig. 2, Plate XIX., and will then pass to the various modifications introduced to remedy its defects.

§ 29. *Form of Chain with given Load.*—Let the platform be hung from the chain by equidistant vertical rods; then the load may be treated as hanging from each joint where the rods are attached, and will consist at each joint of the weight of one subdivision of the chain and of one subdivision of the platform and its load. If the position of the vertical tie-rods be assumed as definite relatively to the points of suspension, so that the assumed loads on the joints act at known distances from the points of support, a form of chain, which will remain in equilibrium (or undisturbed) under these loads, can easily be found by the following graphic method:—

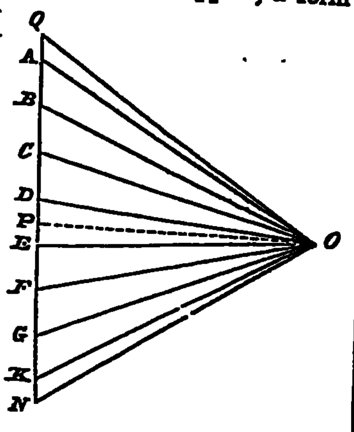


Fig. 30.

Let the vertical line QN (fig. 30) represent the whole load to be carried, and the subdivisions QA, AB, BC, CD, &c., the loads referred to each joint of the chain (QA and NK will be the portion of the load referred directly to the saddle or point of support, and will be simply half the weight of the piece of chain between the saddle and the joint pin). Let QP and NP be the weights carried by each pier,—equal if the distribution of load is symmetrical, otherwise to be determined as for a girder. Let a horizontal line, PO, represent the horizontal component of the tension to be allowed on the chain, or the whole tension on that part of the chain the tangent to which is horizontal; join O with Q, with A, B, &c.; then the lines OA, OB, &c., give the slopes of each successive link as shown in fig. 31, where the line parallel to OA in fig. 30 lies between the two spaces containing the letters O and A in fig. 31, similarly

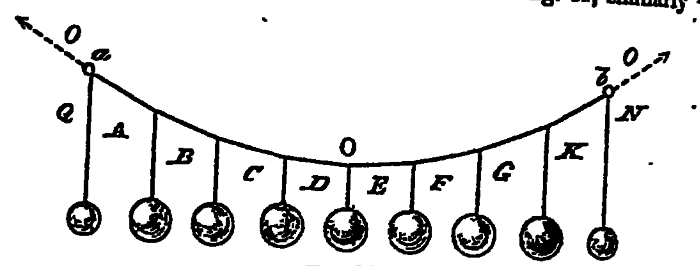


Fig. 31.

the line parallel to OB in fig. 30 is represented by the link between the two spaces lettered O and B in fig. 31, and so forth. The line in fig. 31 lying between O and Q parallel to OQ in fig. 30, represents the direction of the force on the point of support a, being equal and opposite to the resultant of the tension on the first link and the weight carried directly by the support. The triangle QOA (fig. 30) is the polygon of forces in equilibrium at the point of support a (fig. 31). The triangle OAB is the polygon of forces in equilibrium at the first joint, and similarly each component triangle of fig. 30 represents the equilibrated forces at one joint of the chain in fig. 31. This theorem is one example of the general theory of reciprocal figures, which will be treated hereafter under the general head of "Frames," § 53.

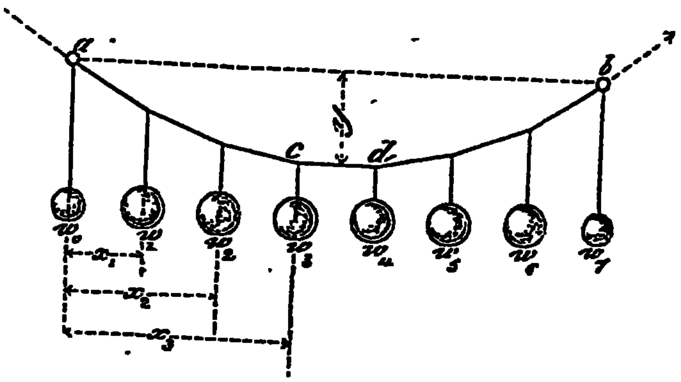


Fig. 32.

When the maximum dip is given instead of the horizontal component of the stress, it is easy to find the latter from the former by the method of moments when the point is known where the chain will be horizontal; for then, let the link cd, fig. 32, be horizontal; let the dip be called y, and let the distances of weights w_1, w_2, w_3, &c., from the point of support a be called x_1, x_2, x_3, &c., and let the horizontal tension represented by PO in fig. 30 be called H. Then taking moments round the point a, we have—

1. . . . . $Hy = \Sigma wx$,

from which H can always be found.

When the length is given of each link (or portion of the chain between the joints where the platform is suspended), and consequently the length of the whole chain, the problem of determining the form assumed under any distribution of load is difficult, for the proportion of the load carried by each pier and the position of each load relatively to the piers vary when the form of the chain varies. The problem may be solved tentatively, but it is seldom attempted.

The converse problem of finding the load which will keep a chain in equilibrium when the dimensions and curve are given is perfectly easy.

From a point O, fig. 30, draw a series of lines parallel to the given links. At any convenient distance, OP, draw a vertical line cutting the lines diverging from O at the points Q, A, B, C, D, &c. The vertical loads required to keep the chain in equilibrium are proportional to the lengths QA, AB, BC, &c.

§ 30. *Relation between the Curve of Bending Moments and the Curve assumed by a Loaded Chain.*—The vertical ordinates at the joints of an equilibrated chain, measured from a horizontal axis passing through the two points of support (these being at the same level), are proportional to the bending moments for similarly chosen sections of a girder similarly loaded.

Let us consider any joint, say that at which w_3 is hanging in fig. 33. Let V be the vertical component of the resultant pull on the left

hand pier, and H the horizontal component. We know that the vertical component is equal to the whole reaction at the pier

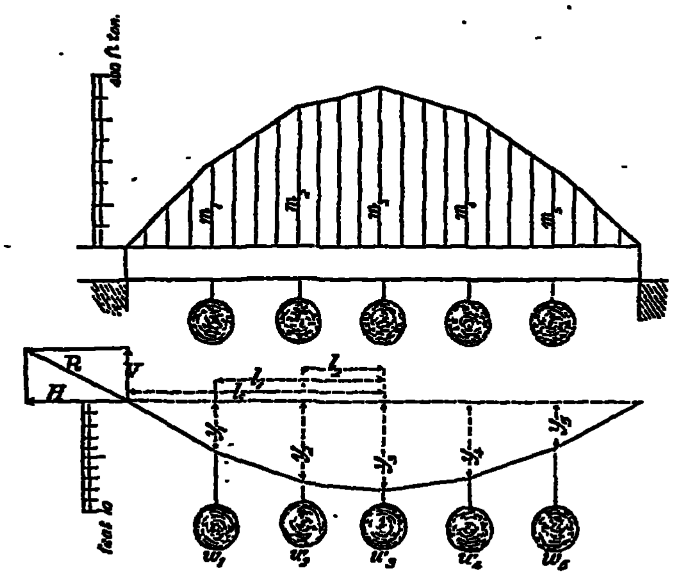


Fig. 33.

when the same load is carried by a girder; then, taking moments about the joint in question, we have—

1. . . . . . $Hy_3 = Vl_0 - w_1l_1 - w_2l_2$,

but the second member of the equation is the bending moment m_3 for the section at a distance l_0 from the pier in a girder of similar span and similarly loaded, therefore, whatever may be the value of H, the values of y_1, y_2, y_3, &c., are proportional to the bending moments. If, then, a curve of bending moments with the ordinates m_1, m_2, m_3, &c., be drawn for a given distribution of load, we can, with a pair of proportional compasses, construct any number of equilibrated curves, by making the values of y in these curves simply proportional to the values of m in the curve of bending moments, and by selection among these a curve of any required length may be found. If H be unity, the ordinates y_1, y_2, y_3, &c., are equal to the bending moments.

§ 31. *Chain Loaded uniformly along a Horizontal Line.*—If the lengths of the links be assumed indefinitely short, the chain under given simple distributions of load will take the form of comparatively simple mathematical curves known as catenaries. The true catenary is that assumed by a chain of uniform weight per unit of length, but the form generally adopted for suspension bridges is that assumed by a chain under a weight uniformly distributed relatively to a horizontal line. This curve is a parabola.

From equation 1, § 30, remembering that Σwl in this case will be equal to $\frac{wL^2}{8}$, we see that the horizontal tension H at the vertex for a span L (the points of support being at equal heights) is given by the expression—

1. . . . . $H = \frac{wL^2}{8y}$,

or, calling x the distance from the vertex to the point of support,

$$H = \frac{wx^2}{2y}.$$

The value of H is equal to the maximum tension on the bottom flange, or compression on the top flange, of a girder of equal span, equally and similarly loaded, and having a depth equal to the dip of the suspension bridge.

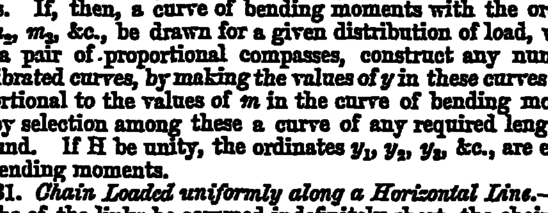


Fig. 34.

Consider any other point F of the curve, fig. 34, at a distance x from the vertex, the horizontal component of the resultant (tangent to the curve) will be unaltered; the vertical component V will be simply the sum of the loads between O and F, or wx. In the triangle FDC, let FD be tangent to the curve, FC vertical, and DC horizontal; these three sides will necessarily be proportional respectively to the resultant tension along the chain at F, the vertical force V passing through the point D, and the horizontal tension at O; hence

$$H : V = DC : FC = \frac{wx^2}{2y} : wx = \frac{x}{2} : y,$$

hence DC is the half of OC, proving the curve to be a parabola.

The value of R, the tension at any point at a distance x from the vertex, is obtained from the equation—

$$R^2 = H^2 + V^2 = \frac{w^2x^4}{4y^2} + w^2x^2,$$

or,

2 . . . . . . $R = wx\sqrt{1+\frac{x^2}{4y^2}}$

Let i be the angle between the tangent at any point having the co-ordinates x and y measured from the vertex, then

3. . . . . $\tan i = \frac{2y}{x}$.

Let the length of half the parabolic chain be called s, then

4. . . . . $s = x + \frac{2y^2}{3x}$.

The following is the approximate expression for the relation between a change Δs in the length of the half chain and the corresponding change Δy in the dip:—

$$s + \Delta s = x + \frac{2}{3x}\left\{y^2 + 2y\Delta y + (\Delta y)^2\right\} = x + \frac{2y^2}{3x} + \frac{4y\Delta y}{3x} + \frac{2\Delta y^2}{3x},$$

or, neglecting the last term,

5. . . . . $\Delta s = \frac{4}{3}\frac{y\Delta y}{x}$

and

6. . . . . $\Delta y = \frac{3}{4}\frac{x}{y}\Delta s$.

From these equations the deflection produced by any given stress on the chains or by a change of temperature can be calculated.

If the points of support are not at equal height (fig. 35) call the heights above the vertex y and y_1, and the horizontal distances of

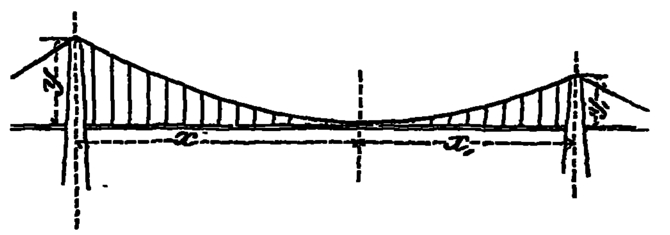


Fig. 35.

the vertex from the points of support x and x_1; let y and y_1 be given, and x, x_1 unknown.

The horizontal stress at the vertex will be the same as if the bridge were composed of two symmetrical halves, each having a span $2x$ and a dip y, or of two symmetrical halves, with a span $2x_1$ and a dip y_1; in other words—

$$H = \frac{wx^2}{2y} = \frac{wx_1^2}{2y_1},$$

hence

7. . . . . $\frac{x^2}{y} = \frac{x_1^2}{y_1}$,

or,

$$x : x_1 = \sqrt{y} : \sqrt{y_1};$$

thus, to find the horizontal position of the vertex, we have only to subdivide the span in the ratio $\sqrt{y} : \sqrt{y_1}$; we may then calculate the strains on one side of the vertex as for half a bridge with the span $2x$ and the dip y, and on the other side of the vertex as for half a bridge with the span $2x_1$ and the dip y_1. The device of piers of different heights may be used with advantage when it is desired to throw a larger portion of the weight of the bridge on one pier than the other, because of a difference in the soundness of the foundations, or for other reasons. The stresses on the loaded and unloaded portion of the chains between the piers and the anchorage are easily determined by methods similar to those which have been given for the stresses on each part of the main span. The same methods also give the direction of each successive link, and of the final links leading to the anchorage.

§ 32. *Practical Details.* — The chains of suspension bridges are either long wire ropes or true chains made of links pinned together. Wire ropes allow the strongest known material to be adopted, namely, steel wire, which

can be bought in large quantities of a quality which does not break with less than a stress of from 55 to 60 tons per square inch of section; charcoal iron wire of the sizes used will bear 40 tons per square inch; common sizes of wire for the purpose are from 0·16 to 0·14 inches, or say, No. 9 or 10 Birmingham wire gauge. Three or four thousand wires are not unfrequently used in one cable, and it is very essential that each wire shall take an equal part of the whole stress. It used to be thought necessary to ensure this by straining each wire separately either over the actual piers, or piers similarly placed, and binding them together when hanging, strained by their own weight with the dip proposed for the bridge. It was also thought essential that each rope should be an aggregate of parallel wires, not spun as in a hempen rope. Experiment has shown, however, that wire ropes spun with machines which do not put a twist into each wire, but lay it helically and untwisted, and with no straight central wire, are as strong as wire ropes of equal weight made with straight wires. They are, however, much more easily made. A number of ropes of this kind may, therefore, with more convenience and economy be bound together into one cable in the manner previously practised for single wires. Care should be taken to fill every interstice of the ropes with a bituminous compound.

When the chains are made of links of iron their ultimate strength cannot be taken as more than 30 tons per square inch, even if the very best material is secured. It is doubtful if this ultimate strength can at present be surpassed by steel links, for although many steel links of greater strength could certainly be obtained, occasionally a comparatively weak link will be produced even by the

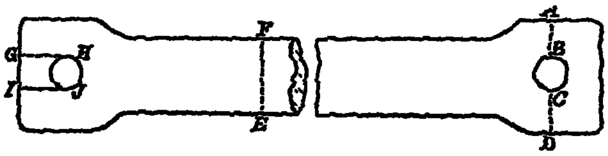


Fig. 36.

best manufacturers. In designing the links care must be taken to provide sufficient cross section at the eye, AB+CD, fig. 36, as well as at EF. The diameter of the pin BC must be such as will allow it to resist the shearing stress on it, and the surface of the pin and eye from B to C must be sufficient to bear the crushing stress. Otherwise, although the pin may not be shorn it may be squeezed flat, and the head of the link may bulge out and be much distorted under the stress. To obtain the necessary surface, without unduly increasing the diameter of the pin, the link may be rolled with a head

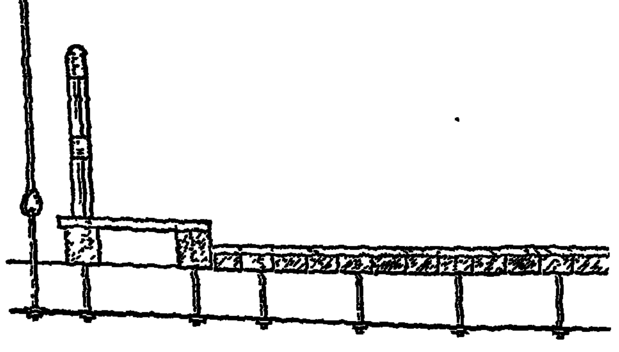


Fig. 37.

broader than the body of the link. The section at GH and IJ must also be sufficient to resist shearing. When two or more parallel chains are used, care must be taken that the rods suspending the platform bear equally on the several chains. Fig. 37 shows a plan of securing this. Chains of unequal dip should not be used to support one platform, for the strain cannot be equally divided between them, inasmuch as they must deflect unequally with any passing load, or with any increase of temperature.

§ 33. *Merits and Defects of Suspension Bridges.*—The great merit of a suspension bridge is its cheapness, arising from the comparatively small quantity of material required to carry a given passing load across a given span. This merit may be easily seen by considering an elementary example. A man might cross a chasm of 100 feet hanging to a steel wire 0·21 inches in diameter, dipping 10 feet; the weight of the wire would be 12·75 ℔. A wrought iron beam of rectangular section, three times as deep as it is broad, would have to be about 27 inches deep and 9 inches broad to carry him *and its own weight.* It would weigh 87,500 ℔. An iron I beam of the best construction, 10 feet deep, would weigh about 120 ℔, without allowing anything for the stiffening of the centre web which would in practice be required. In each case four feet in length have been allowed for bearings at the ends of the span. The enormous difference would not exist if the beam and wire had only to carry the man, although even then there would be a great difference in favour of the wire; the main difference arises from the fact that the bridge has to carry *its own weight.* The chief merit of the suspension bridge does not, therefore, come into play until the weight of the rope or beam is considerable when compared with the platform and rolling load; for although the chain will for any given load be lighter than a beam, the saving in this respect will for small spans be more than compensated by the expense of the anchorages. In large spans the advantage of the suspension bridge is so great that we find bridges on this principle of 800 or 900 feet span constructed at much less cost per foot run than girder bridges of half the span. The disadvantages of the suspension bridge are, however, very great. A change in the distribution of the load causes a very sensible deformation of the structure; for the chain of the suspension bridge must adapt its form to the new position of the load, whereas in the beam the deformation is hardly sensible, equilibrium being attained by a new distribution of the stresses through the material. This flexibility of the suspension bridge renders it unsuitable for the passage of a railway train at any considerable speed. The platform rises up as a wave in front of any rapidly advancing load, and the masses in motion produce stresses much greater than those which could result from the same weights when at rest; moreover, the kinetic effect of the oscillations produced by bodies of men marching, or even by impulses due to wind, may give rise to strains which cannot be foreseen, and which have actually caused the failure of some suspension bridges. On the 16th of April 1850 a suspension bridge at Angers gave way when 487 soldiers were passing, and of these 226 were killed by the accident. Another danger peculiar to suspension bridges is that the platform may be lifted by the wind, when its oscillation will produce most dangerous strains. This accident may be prevented by tying the platform down to the piers or abutments. Lateral oscillation produced by the wind is also dangerous, and even gathered ice and snow may be a serious increment to the load on these bridges, forming a much more considerable fraction of the whole weight than where the supporting structure is itself massive. Suspension bridges must be well cross-braced to resist the action of the wind. They can be much stiffened laterally by placing the chains in inclined planes, converging downwards to the platform.

§ 34. *Modifications of the Simple Suspension Bridge.*—Many efforts have been made to design a bridge which

shall combine the lightness of the true suspension bridge with the stiffness of the girder. Mr Dredge's design with sloping rods (fig. 38) gives a somewhat stiffer structure

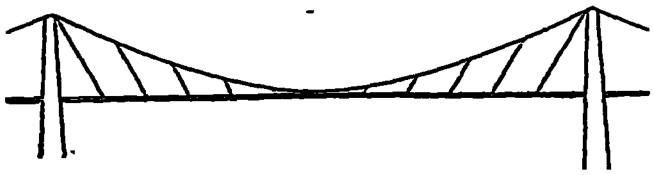


Fig. 38.

than the bridge with vertical suspension rods; the inclined rods throw a strain on the platform, which must be resisted either by ties along the central portion, or by struts abutting against the piers. The stresses on each part will be shown under the heading "Compound Structures" (§ 62).

The design fig. 39 has been proposed by many, but is

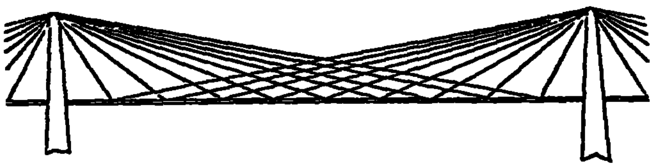


Fig. 39.

worthless. The object of the proposers is to support each part of the platform by rods which are quite independent of other parts of the structure, and which, being originally straight, do not alter their form under stress. The unequal stretching of the long and short rods under a stress, or with a rise of temperature, is a radical defect. Mr Ordish has proposed a plan in which the road is supported by sloping tie rods, arranged like the struts in fig. 87, inverted. Flexible chains, like that of an ordinary suspension bridge, carry the weight of these tie rods by vertical rods, which keep the sloping rods straight. The chain in this form is not subjected to unequal loading. Various forms of bridge have been proposed, in which, as in figs. 76 and 78, two chains are braced together. These may be made thoroughly stiff bridges, with a moderate increase in the amount of metal required for the flexible bridge. They will be described under the head of "Frames." Stiffness has also been obtained in some structures by using an auxiliary girder to stiffen the platform. This is best effected by the use for each chain of two girders, each half the length of the platform. These girders are placed as in fig. 40, being hinged together by a strong pin at B, and

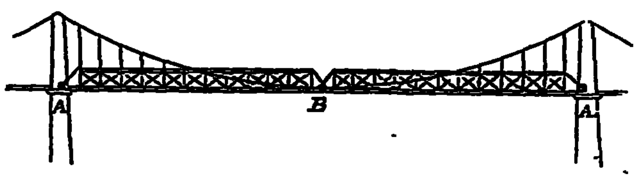


Fig. 40.

held down by pins at A and A_1, which should, however, be left free to move horizontally. These girders are not sensibly strained by the rise and fall of the chains due to a fall or rise of temperature; they can also deflect freely as a whole when the chain is deflected under strain; nevertheless, they serve to distribute the weight of a passing load over the chain, so that it cannot be sensibly distorted. Rankine has given the following rule for designing these stiffening girders. Let w_1 be the greatest rolling load per foot run; let x be the half span of the chain; let M be the greatest bending moment which the auxiliary girders will have to resist (*i.e.*, at the centre of each); let F be the greatest shearing force (at the end and central pins), then

1. . . . . . . $M=\frac{1}{16}w_1x^2$,

and

2. . . . . . . $F=\frac{1}{4}w_1x$.

Each auxiliary half girder is in fact to be designed as a beam of half the span of the bridge, and capable of carrying half the passing load per foot run (but not its own weight). This plan of stiffening is quite effective, but adds considerably to the weight and cost of the whole structure; for not only have we to provide these extra girders, but extra material in the chains to carry this extra dead load.

§ 35. *Maximum Span.*—If we assume that wire can be obtained which will safely bear 15 tons per square inch, a rope (or single wire) with a dip of $\frac{1}{12}$th of the span would safely bear its own weight over a span of about one mile, and would not break till the span exceeded 4 miles. With a dip of $\frac{1}{7}$th of the span a steel wire rope of the best quality would not break until the span exceeded 7 miles. These lengths are not given as indicating practical spans for bridges, but to show the limits which with our present materials cannot be exceeded, however light the passing load may be.

IV. The Arch.

§ 36. *General Description.*—An arch may be of stone, brick, wood, or metal. The oldest arches are of stone or brick. They differ from metal or wooden arches, inasmuch as the compressed arc of materials called the *ring* (fig. 41, London Bridge), is built of a number of separate pieces

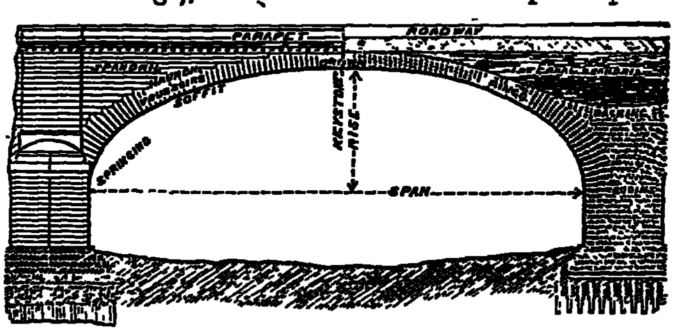


FIG. 41.—Half Elevation and Half Section of Arch of London Bridge.

having little or no cohesion. Each separate stone used in building the *ring* has received the name of *voussoir*, or archstone. The lower surface of the ring is called the *soffit* of the arch. The *joints*, or bed-joints, are the surfaces separating the voussoirs, and are normal to the soffit. A brick arch is usually built in numerous rings, so that it cannot be conceived as built of voussoirs with plane joints passing straight through the ring. The bed-joints of a brick arch may be considered as stepped and interlocked. This interlocking will affect the stability of the arch only in those cases where one voussoir tends to slip along its neighbour. The ring springs from a course of stones in the abutments, called *quoins*. The plane of demarcation between the ring and the abutment is called the *springing* of the arch. The *crown* of the arch is the summit of the ring. The voussoirs at the crown are called *keystones*. The *haunches* of the arch are the parts midway between the springing and the crown. The upper surface of the ring is sometimes improperly called the extrados, and the lower surface is more properly called the intrados. These terms, when properly employed, have reference to a mathematical theory of the arch little used by engineers. The walls which rest upon the ring along the arch, and rise either to the parapet or roadway, are called *spandrils*. There are necessarily two outer spandrils forming the faces of the bridge; there may be one or more inner spandrils. The *backing* of an arch is the

masonry above the haunches of the ring; it is carried back between the spandrils to the pier or abutment. If the backing is not carried up to the roadway, as is seldom the case, the rough material employed between the backing and the roadway is called the *filling*. The *parapet* rests on the outer spandrils. The abutments and piers have the same signification as in other bridges. The masonry arch differs from the superstructure of other bridges in the following respect: it depends for its stability on the presence of a permanent load specially arranged, and so considerable in amount that the changes produced in the direction and magnitude of the stresses by the passing load are insignificant. The theories of the masonry arch often neglect the passing load entirely, and simply teach the student how to distribute the permanent load, so that the voussoirs may be in equilibrium. The permanent load consists of the ring, the backing, the filling, the spandrils, and the roadway. Inasmuch as the ring is that part of the structure which by its special strength and arrangement carries the superstructure in the same sense as a beam or chain carries it, the arch in this article will be treated simply as a ring of voussoirs springing from two abutments and loaded with weights, some permanent and some passing. Where the backing strengthens the arch, it becomes virtually part of the ring.

§ 37. *Equilibrium of a Single Voussoir.*—A block, such as a voussoir, ABCD, fig. 42, resting on one of its surfaces, such as the joint AB separating it from the next voussoir, is in equilibrium when the resultant of all the forces acting upon it (including its own weight) falls within the supporting surface, while the direction of this resultant makes an angle ϕ with the normal to the surface less than the angle of repose; (the tangent of the angle of repose is the coefficient of friction).

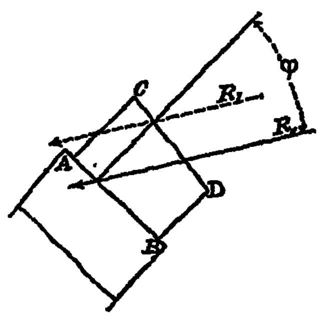


Fig. 42.

If the resultant, as $R_{\prime}$, falls without the surface, the block will heel over, pivoting on the edge A. If the resultant, as $R_{\prime\prime}$, although falling within the surface of which AB is the trace, is yet much inclined to the normal, the block ABCD will slide up on the joint AB without heeling over. The block, if used as the voussoir of a bridge, must not only be in equilibrium under the forces applied to it, but must also be of sufficient strength to resist these forces. The intensity of crushing stress due to the external forces must nowhere exceed the safe crushing strength of the material. This latter condition would in most arches be fulfilled by an extremely thin ring of stones or brick if the resultant passed through the geometrical centre of the joint AB in a direction normal to it. In that case the stress on the joint would be a uniformly distributed stress; if, however, the resultant stress passes near one edge, the intensity of stress at that edge will be much greater than elsewhere, and would indeed be infinite if the resultant passed exactly through the edge at A or B; while, therefore, the condition of equilibrium is satisfied if the resultant passes within either edge of the voussoir at no great inclination, the condition of strength requires that this resultant shall not cut the joint very near the edge, and the common practical rule is that it shall always fall within the middle third of the joint. This rule is based on the condition that the pressure on a joint shall nowhere be negative; in other words, that no tension shall occur at any part of any joint. The principles explained in § 8 show that the minimum stress on any joint $p_1 = p_0 - \frac{Px_0x_1}{I}$, or that the stress will be zero, when $p_0 = \frac{Px_0x_1}{I}$. Let d be the depth of the rectangular joint, and b the breadth; then

$$I = \frac{bd^3}{12}, \text{ and } x_1 = \frac{d}{2}, \text{ and } p_0 = \frac{P}{bd};$$

hence

$$\frac{P}{bd} = \frac{12Px_0d}{2bd^3}, \text{ or } \frac{d}{6} = x_0,$$

an equation expressing the condition that the centre of pressure lies at the edge of the middle third; any greater value of x_0 will give a negative value to p_1. We shall see that the actual resultant is, according to the theory practically in use, indeterminate within certain limits; it is therefore useless to attempt to calculate the exact maximum stress on any one stone. In the rest of this article the *ring* is to be held to mean the *middle third* of the actual masonry, or brick ring, wherever the theory requires that the blocks are to resist practical loads. As bridges are subject to a sensibly equal load on all parts of their breadth between the parapets, it is usual to consider a portion of the ring one foot in width, each other strip being under precisely similar conditions. Similarly the joint may be spoken of for convenience as the line which is its trace, and the edge as the point which is its trace.

The external forces which act on any voussoir are—1st, the vertical force, being the resultant of its own weight and the load which is directly over it; 2d, the thrust from the voussoir above it; and 3d, the reaction from the voussoir on which it rests (fig. 43). It is sometimes difficult to determine exactly what portion of the superincumbent load a voussoir may properly be said to carry, but a sufficient approximation is obtained for practical purposes by assuming that the mass vertically above any voussoir is carried by the voussoir when the back of the voussoir is not much inclined. If the materials had little cohesion, the direction of the force produced by the load would not be vertical, but inclined at an angle depending on the coefficient of friction; in practice, the direction of the force is uncertain and even variable with changes in the condition of the superincumbent filling. If, however, the stability of the arch is calculated with a reasonable margin or coefficient of safety, on the hypothesis that the force produced by the load is vertical, there is every probability that the arch will be stable under any actual stress which may arise in practice.

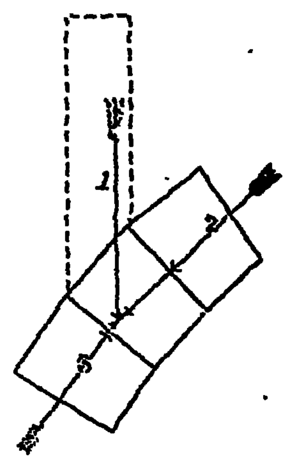


Fig 43.

§ 38. *Equilibrium of any three Voussoirs; Equilibrated Polygon.*—The simplest arch would be an arch of three voussoirs resting on two abutments, and any actual arch consisting of many voussoirs may be considered as composed of successive triplets, the voussoirs on each side of which act as abutments. If, therefore, we can show the conditions of equilibrium for three voussoirs we shall have determined the conditions for the whole ring.

Let three voussoirs be taken from any part of the ring (fig. 44), and let the lines 1, 2, and 3 represent the position of the resultants of the three known loads w_1, w_2, and w_3 (including the weight of the voussoirs) borne by each voussoir.

Let NA represent the position of the reaction t due to the abutting voussoir on one side. Let A be the point where the prolongation of the line NA cuts the line 1; then if the magnitude of the

forces t and w_1 are known, these determine the magnitude and direction of the equilibrating force t_1, which must act at A to balance them. Let the direction AB and the magnitude of the force t_1 be

Fig. 44a.

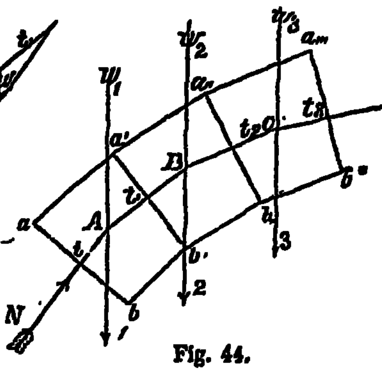


Fig. 44.

found by the ordinary parallelogram of forces, as in fig. 44a, and let B be the point of intersection of the direction of this force with the line 2; then the direction and the magnitude of the equilibrating force t_2 can be found as for t_1; similarly the direction of this force gives the point C by its intersection with the line 3, and finally we obtain, by the resolution of forces, the direction, magnitude, and position of the force t_3, by means of which the reaction of the second abutment will keep the system in equilibrium. When the position and magnitude of t are known, the position and magnitude of all the other forces are determinate; the conditions of equilibrium are that *the lines NA, AB, BC, and CQ, shall not cut the joints above* or below the edges a or b, for in that case the blocks would heel over on the edge beyond which the resultant passed; also, the direction of the lines NA, AB, &c., must be such as not to exceed the angle of repose with the normal to the *joints, otherwise* one stone will slip on the other. The abutment producing by its reaction the force t_3 must not yield with a less force than t_3, and must not be pushed forward so as to produce a greater force than t_3. The line NABCQ, if inverted, is in form identical with that which a cord would assume, loaded at the points A, B, and C, with the loads 1, 2, and 3, and having the direction of NA determined. This line will, in the rest of this article, be called an *equilibrated polygon*.

When the joints are supposed indefinitely near, or the voussoirs thin sheets, the equilibrated polygon becomes a curve called a *linear arch*.

The reasoning applied to three blocks is clearly applicable to any number, and we may therefore say that any series of loaded voussoirs will be in equilibrium when a reaction of known magnitude and direction is applied at one abutment, provided the equilibrated polygon required by this reaction and the given loads can be drawn so that its sides cut all the joints within the ring (or within the

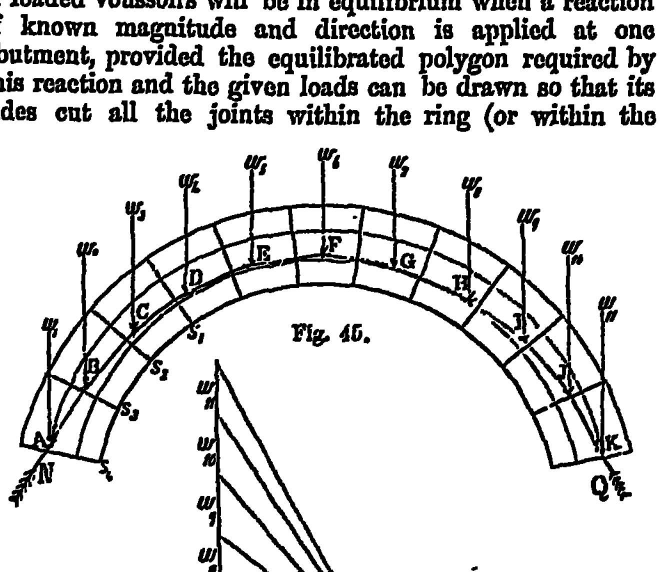


Fig. 45.

Fig. 45a

middle third, where strength is an element of the question*)* *at an angle greater than the complement of the angle of* repose for the material used. An equilibrated polygon, ABC... ..Q, for a complete arch is shown in fig. 45 Fig. 45a is the diagram giving the slopes KJ, JI, &c., as for the loaded chain fig. 30 and 31.

§ 39. *It will be shown in next paragraph that the arch* will be in equilibrium if with any value of the horizontal thrust h an equilibrated polygon can be drawn fulfilling the conditions required. In most arches equilibrated polygons fulfilling these conditions can be drawn with values of h *varying between two limits differing* by a considerable amount. In that case the smallest value of h will be the true value, and give the true stresses; for the abutments being inert will not give back a greater thrust than is just required to balance the structure. This would render the thrust h determinate if the equilibrated polygon might actually approach the true edge of the ring, but as this would require infinitely strong materials, we are still left in uncertainty as to the true value of h, but may feel sure that it will be the smallest value consistent with a safe stress on the material. If we provide abutments capable of reacting with a force h sufficient to keep the equilibrated polygon (where it cuts the joints) within the middle third, our abutment will certainly be amply strong enough, and this is the value of h to be adopted in all practical calculations of the stability of an arch.

In the example with the three voussoirs it is clear that equilibrium would be obtained with very widely different reactions t at the one abutment. And this fact is also true for a bridge of many voussoirs. The vertical component (which may be called v) *of this total thrust t is* indeed determinate if we suppose the point where t cuts *the joint to be known, being the same as the vertical reac*tion from a beam carrying the same weights and supported at the points where t and v cut the abutments; but the horizontal component or horizontal thrust, which has been called h, cannot be determined by any considerations hitherto mentioned.

§ 40. *Experimental Demonstration that the Equilibrium of a series of Voussoirs is stable if any Equilibrated Polygon can be drawn fulfilling the conditions stated above.*—Let us suppose an arch, fig. 48, to be constructed, the bed-joints of which are not plane but curved, so that each stone touches its neighbour only along a horizontal line, the trace of which in a drawing may be called the *point of contact.* Such an arch will differ from an ordinary arch in this respect, that the centre of pressure at joints will be shown by the points of contact, while the stones will be able by rolling to alter the points of contact if not in equilibrium. In such an arch the voussoirs in the first place may be put together so as to touch at any desired series of points, but the forces called into play when external support is withdrawn will rearrange the voussoirs so as to bring them into equilibrium, if any equilibrated arch consistent with the loads can be drawn so that the lines forming it cut the joints inside the ring, and a model will show the points of contact, or, in other words, the places where these lines cut the joints. (It is assumed that the obliquity of the sides of the polygon to the joints which they cut is insufficient to produce slipping.)

An actual model shows the action very prettily, but the following considerations will easily allow the student to see how it is that the voussoirs always arrange themselves so as to build a true arch.

Suppose, first, that the arch consisted merely of three stones, fig. 46, and that the weight on the centre one was so great that the linear arch, or equilibrated polygon, became sensibly two inclined straight lines like rafters. As soon as the voussoirs are left to themselves, the pressure at the surface a_2 b_2, and the reaction at the surface a_1 b_1, will lie in one straight line, which, *meeting a similar* straight line from the other abutment, will give one equilibrated polygon, satisfying the required conditions; but if the horizontal force required for this polygon is not supplied by the abutments, the two *forces* at joints 1 and 2 will, as shown by the small straight arrows, constitute a couple tending to turn the stone A round, so that the point of contact at joint 1 will be lower, and the point of contact in joint 2 will be higher than before. The same action will occur in stone C, and the result will be that the weight may be balanced with a smaller horizontal force. At the

same time the rotation of the stones A and C, coupled with the descent of B, tends to push back the abutments N and Q, and therefore to increase their horizontal reaction supposing them to be stable. If the abutments N, Q continue to yield, the stones A

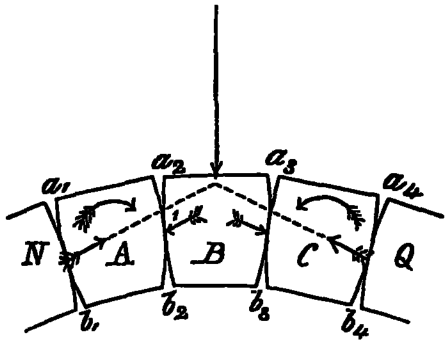


Fig. 46.

and B will continue to turn until the points of contact reach a_2 and a_3, or b_1 and b_4. The horizontal thrust which the abutments require to meet will therefore diminish as the stones turn, and the little structure will only fail to support the weight in case the abutments N and Q are insufficiently strong or stable to supply the minimum thrust consistent with an equilibrated polygon

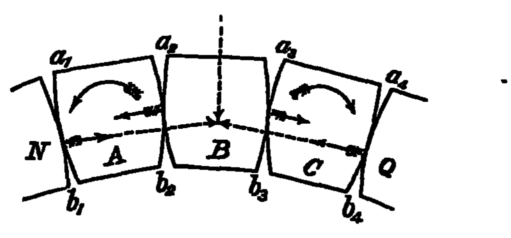


Fig. 47.

cutting the joints inside the ring (or in case the polygon cut the joints at such an angle that the stones slip). If, on the other hand, the abutments were so made as to press in upon A and C with a greater horizontal force than is consistent with two lines of pressure passing through the actual points of contact, then, as in fig. 47, the direction of the couples on the stones A and B would be reversed, and they will roll round so as to bring the points of contact more nearly into the position required to meet an excessive horizontal thrust, and at the same time the changed position of the stones, by allowing N and Q to come forward, will tend to relieve or diminish the original excessive horizontal thrust, where this is due to the elasticity of the stones N and Q, or of the stones supporting these abutments. The structure will not fail unless the points of contact reach a_1 and a_4, or b_2 and b_3, when the structure would fail by the sides being squeezed in, and the stone B being lifted up out of the arch. This could not happen with stones of the proportions shown in fig. 47, as before the limiting position was reached, the points of contact would lie on a straight line corresponding to an infinite horizontal thrust. In conclusion we see that, whether the horizontal force supplied by the reaction of the abutting stones be too small or too great, the three voussoirs tend to move so as to adapt the centre of pressure and the actual horizontal force to one another. The equilibrium produced is stable, that is to say, if by some external force the arrangement of the blocks is slightly disturbed, when the force is removed the blocks return to their original position. In the above demonstration it is assumed that the blocks when first put together touch at some point not far from the centre of the bed,—a condition corresponding to reasonably good fitting in the case of the plane joints of a stone arch before the centring is removed.

If a model be prepared (fig. 48), having a number of voussoirs of wood with their bed-joints slightly curved and roughened, the result of the above theory will be very clearly and beautifully seen. The action explained in the case of three blocks holds good for any three, and therefore for the whole series. If an additional weight is placed at the crown, as in fig. 48, the crown is a little lowered, but the curve passing through the lines of contact rises at the crown and is lowered at the haunch by the rotation of the blocks, until the lines of contact at the joints arrange themselves, so that the resultant pressures forming the imaginary polygon pass through these lines of contact. If the extra load be placed at the haunches the crown rises, but the points or lines of contact between the voussoirs are lowered at the crown and raised at the haunches, as in fig. 48a. If one haunch only is weighted, the curve passing through the lines of contact rises at that haunch and is lowered at the other, as in fig. 48b; if the model be distorted by the hand it oscillates up and down on each side of the position of equilibrium, as a string similarly loaded would do. Figures 48, 48a, and 48b are taken from photographs of a model. (It should be remarked that the abut-

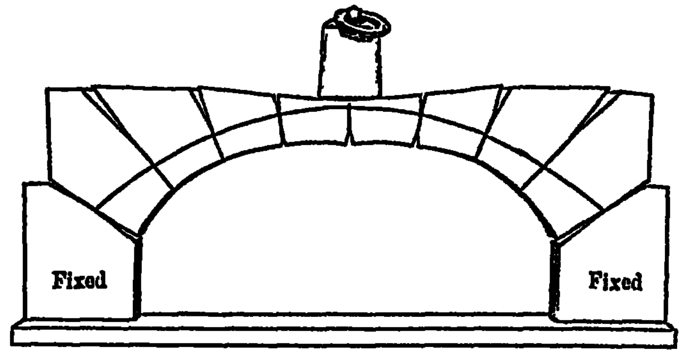


Fig. 48.

ments were screwed to the supporting board; it is obvious that otherwise they would not have been in equilibrium.) The general character of the curve passing through the points of contact may be easily conceived by thinking of a string similarly loaded and

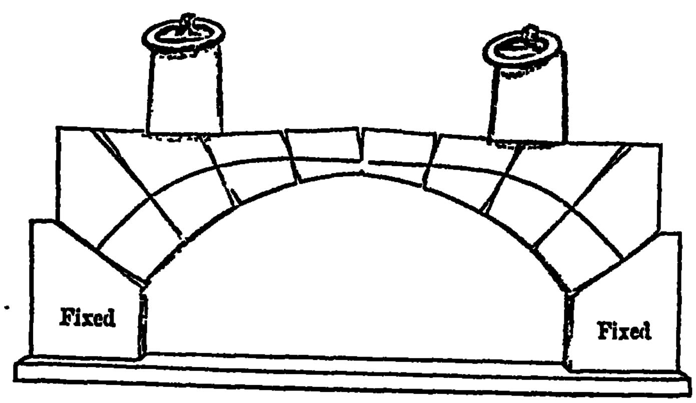


Fig. 48a.

inverted. The equilibrated arch will be one of those forms which a string might take when similarly loaded, but when the load is changed, the length of the curve will not be constant in the arch, whereas it must be constant with any given chain. The curve pass-

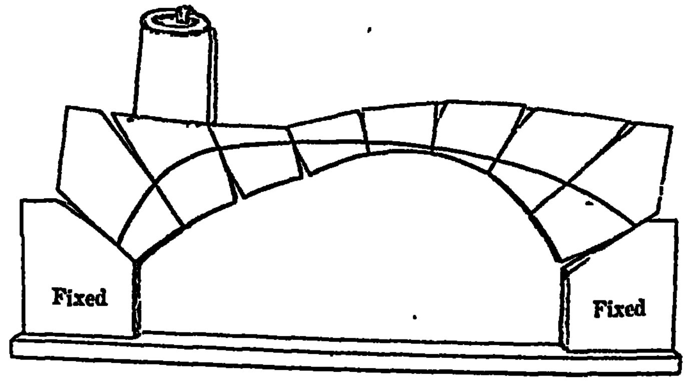


Fig. 48b.

ing through the points of *contact* corresponds with what Moseley called the line of resistance. The direction of the pressure is not necessarily tangent to this curve, but in the ordinary form of bridge it is nearly so.

In the model each voussoir is free to roll, because the bed-joints are curved. In an actual bridge the bed-joints are plane, nevertheless, the stones do turn round to adapt themselves to the pressure, but the result of this rotation is to render the compression along the upper and lower halves of the stone unequal. One edge is more compressed than the other; the couple tending to turn the voussoir, and actually allowed to do so in the model, is met by an equal and opposite couple, due to the unequal compression of the stone.

This couple is the necessary result of a pressure which is not axial, *vide* § 8; an equilibrated polygon cutting the joints at various distances from the centre is therefore as correct an indication of the actual forces present in a practical arch with flat joints as in the model with curved joints; but we must remember that where the joints are flat, the pressure will be unequally distributed wherever the line of the equilibrated polygon does not cut the centre of the

joint. Greater or less elastic resistance in the stone corresponds to greater or less curvature in the surface of the joint. A small distortion of the arch will restore equilibrium when the curvature is great, or when the stone has a high modulus of elasticity. The ring with plane bed-joints is in stable equilibrium, and adapts itself to new distributions of load for precisely the same reasons as the model with curved joints, but in the one case the couple called into play to move the voussoir is actually cancelled by the new position which the points of contact assume; in the other case it is balanced by the equal and opposite couple resulting from the resistance to motion due to the hardness of the stone.

The preceding paragraph showed how to determine whether an arch was in equilibrium when a known reaction was applied at one abutment; the experiment and reasoning now given show that the incipient yielding of an arch under loads will produce a reaction at the abutments suited to keep the whole ring in equilibrium, provided only an equilibrated polygon can be drawn, cutting the joints within the ring at suitable angles.

§ 41. *Practical Investigation of the Stability of a given Arch under a given Load—Joint of Rupture.*—This investigation resolves itself into finding that equilibrated polygon or linear arch which can be drawn within the (middle third of the) ring from the crown to the *lowest possible joint* of the ring (or to the springing if this be possible). This lowest possible joint must in any case be treated as the springing of the arch, and if the linear arch goes out of the (middle third of the) ring above the actual springing, as will be the case in all semicircular or elliptical rings, masonry must be provided in the backing capable of taking the actual thrust into the abutment and constituting the real arch, which often differs widely from the form indicated by the ring of stones in the face. The linear arch in a circular or segmental bridge loaded simply by its own weight generally has a smaller radius of curvature than the ring at the crown, and a much larger radius towards the haunches. Consequently, the longest linear arch which can be drawn within the ring will approach the upper surface of the ring at the crown and the soffit towards the haunches.

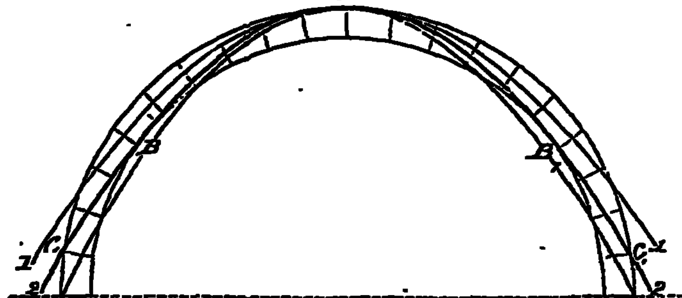


Fig. 49.

Fig. 49 shows a series of linear arches, all drawn for the same load, and all tangent to the upper surface of the crown of the arch, differing only in being the result of different horizontal thrusts. The curve drawn with a thick black line, tangent to the soffit, is clearly the longest linear arch which can be drawn within the ring. Any smaller value of the horizontal thrust h would give a linear arch like curve 3, and any larger value of h would give a linear arch like curve 1, and both these values of h are incompatible with equilibrium for the whole arch down to joint C; if, therefore, the arch fails by the yielding of the abutment, or of the lower portion of the ring, the failure will first be apparent at the joints A and B, where this black line is tangent to the ring, and at joint C, where the linear arch cuts the back of the ring. Smaller values of h will keep the stones in equilibrium above and below joint B, but unless the arch below the joint B, as well as the abutment, can resist the tendency of the arch to spread, or, in other words, supply *at least* the horizontal reaction h required for this linear arch, the joint B will open at the top, the centre joint A will open at the bottom, the joint C will open at the back, and the crown fall in as shown in fig. 49*a*. The joint B, where the longest linear arch is tangent to the soffit, is called the *joint of rupture*. The value of h required to make a linear arch tangent to the back of the ring at the crown pass through the edge of the joint of rupture at the soffit, is larger than the value of h required to give a linear arch passing through the edge of any other joint at the soffit; at the same time, it is the smallest value of h consistently with which the arch can remain in

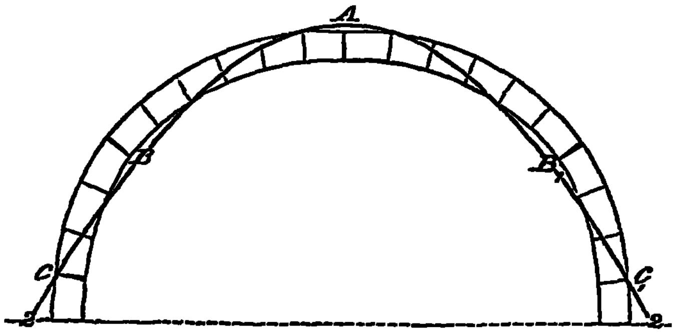


Fig. 49*a*.

equilibrium down to B and from B to C. In circular arches the joint of rupture generally makes an angle of about 30° with the horizontal plane; in elliptical arches the angle is usually about 45°. Its position is easily found as follows:—Let y_1, y_2, y_3, &c. (fig. 50), be the heights of the upper surface of the crown A above any points

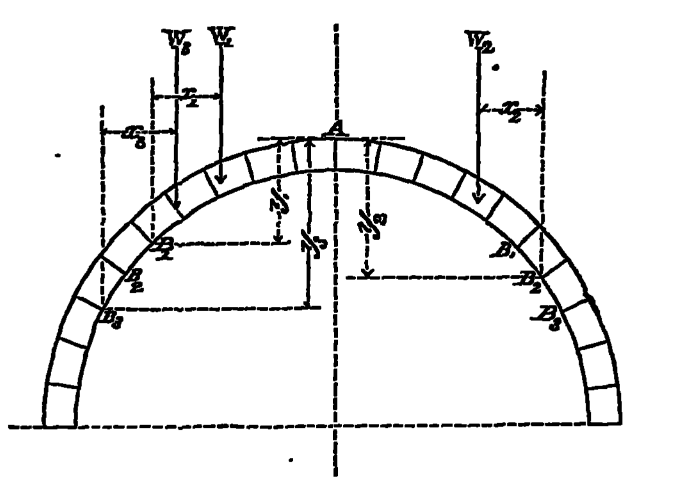


Fig. 50.

B_1, B_2, B_3 at the lower edges of the soffit; let W_1, W_2, W_3 be the weights of the portions of the arch with its load carried by the ring from B_1 to A, from B_2 to A, from B_3 to A, &c. (The load is in the fig. assumed to be symmetrically disposed relatively to the centre of the span.) Let x_1, x_2, x_3 be the horizontal distances of the centres of gravity of w_1, w_2, w_3 from the points B_1, B_2, B_3, &c.; then taking moments round B_1, B_2, B_3 in succession, we have, if the linear arch be assumed to pass through any point B—

$$Wx = hy;$$

taking the successive values of h for a series of joints B, we shall find that one joint gives a maximum value. This value corresponds with that of the linear arch tangent to the soffit (of the middle third) at the joint of rupture; for this arch has the maximum thrust *of any passing through the points B_1, B_2, &c., as appears by simple* inspection of fig. 49. The joint of rupture can thus be tentatively found, and the value of h, or the thrust which the abutment must resist, is obtained at the same time. If the backing is carried well up above C, a larger value of h than that obtained by this method would be consistent with the stability of the arch, and might actually occur; but we need not provide for this larger value, since the yielding of the abutment under it would diminish the thrust till it fell to the value as above determined. If the abutments could resist this thrust, the bridge would then remain in equilibrium. If the arch is flat there may be no joint of rupture, and in that case the value of h is to be taken as that given by a linear arch passing through the bottom of the (middle third of the) springing and tangent to the crown of the arch, *i.e.*, to the summit of the middle third of the ring.

When the apparent springing lies much below the joint of rupture, we find that the linear arch leaves the ring on the upper surface at a joint (C) lower down, where failure must result by the opening of the joint at the lower surface, unless the pressure is taken by masonry outside the ring. It is for this purpose that the *backing* is required. Obviously the best mode of supplying backing is to thicken

the ring itself, keeping the masonry joints radial. The portion of the arch below the joint of rupture B is often considered as part of the abutment.

If the load at the crown of an arch were very light, and the load at the haunches comparatively very heavy, the series of tentative curves drawn with various values of h would assume the character shown in fig. 51. The longest curve which can now be fitted into the ring (drawn with a thick black line in the figure) will probably approach the soffit at the crown and be tangent to the upper surface of the ring at the haunch. In fig. 51 the longest linear arch is shown as tangent to the soffit at C. This condition could seldom be secured; with most loads the linear arch tangent to the back of the ring at B will *cut* the soffit at C. Nevertheless, the value of h to be provided for will be that given by the linear arch tangent to the soffit. If *this arch leaves the middle third* at B, the ring must be thickened or efficient backing provided at this point. If the abutment yield an arch thus loaded would *fail*, as in *fig. 51a*, but the case very seldom arises in practice. If the arch were not pointed at A, but curved so as to contain the linear arch near the crown, the piece BAB would be lifted up as a whole without breaking at A.

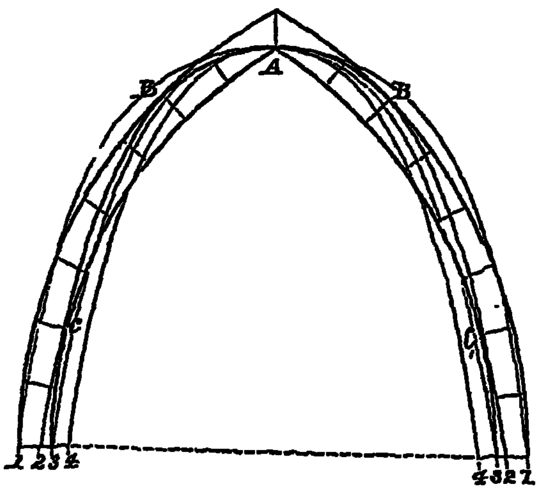


Fig. 51.

The joints of rupture can be found for unsymmetrical loads as well as for symmetrical loads, but these joints will then not be at equal distances from the crown.

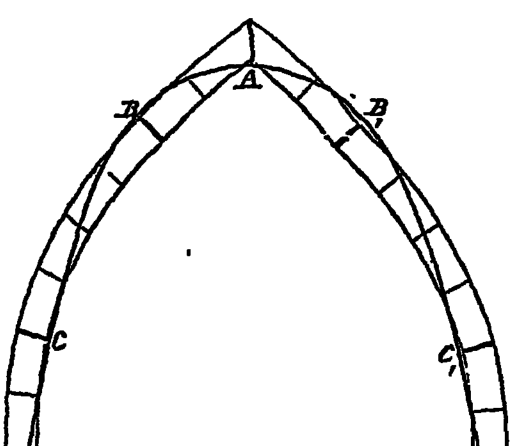


Fig. 51a.

If the middle third of the ring be alone treated as effective, the designer, after finding the joint of rupture for a bridge of the usual form and with usual loads, need make no further calculation as to the arch *above* that joint. A linear arch which is tangent to the soffit at the joint of rupture, and to the upper surface of the ring at the crown, will probably lie within the ring at intermediate joints, and will cut them at an angle not differing much from a right angle; but the linear arch must be carried on below the joint of rupture, through the backing and the abutments, to see that it is nowhere too much inclined to the bedding joints, and never comes too near the edge of the effective masonry. The horizontal thrust determined by finding the joint of rupture on the hypothesis that the middle third of the ring is the only effective part will be a safe value; but the actual value may be considerably less, since the actual linear arch called into play may lie outside the middle third. Since we do not know the actual position of the resultant pressures on each voussoir, any refinement in calculating the maximum intensity of stress due to these resultants would be useless. If the actual horizontal thrust were known, it would be easy to determine the couple acting on each joint and due to the distance between the resultant pressure and the centre of resistance of the joints; then knowing this couple and the total thrust it would be equally easy by the principles in § 8 to determine the maximum intensity of stress. Practically the thickness of the arch ring is determined by rules derived from experience, and the chief use of the above theory is to determine the dimensions of the abutments; if, however, with a given load the joint of rupture were found much nearer the crown than the positions indicated above, it would be well to rearrange the permanent loads or to alter the form of the ring.

§ 42. Professor George Fuller of Belfast has communicated the following novel and very neat method of finding the linear arch of maximum rise (and therefore of minimum thrust) which can be drawn within the middle third of a given ring.

In fig. 52 let the dotted curves GI and HK bound the middle third of the ring. Let the span be divided into any convenient

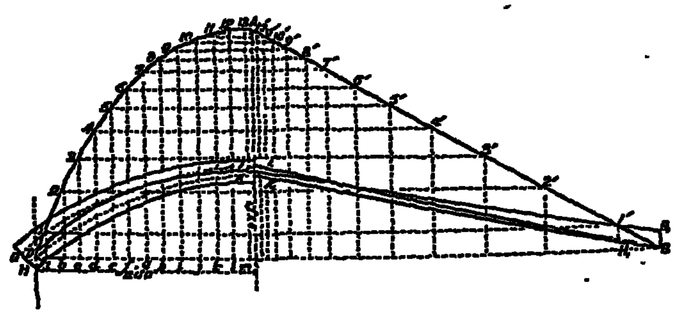


Fig. 52.

number of parts at a, b, c . . . &c. Let the load on the half arch be subdivided into a corresponding number of parts, and each partial load referred to the vertical line passing through a, b, c . . . &c. Let the curve D 1 2 3 . . . A be a curve of bending moments for these loads, drawn to any convenient scale. This curve will also (§ 30) be a linear arch for the given loads. Draw the straight line AB at any convenient inclination, cutting the horizontal line DB at B. Raise the verticals a1, b2, c3, . . . &c., from the points 1, 2, 3, &c. Where these cut the curve DA draw horizontal lines, cutting AB at 1′, 2′, 3′, . . . &c. Since the ordinates of all possible linear arches are merely multiples or submultiples of the curve of bending moments, it follows that any other straight line from B to the vertical through A will have ordinates, which, if measured from DB along the verticals passing through 1′, 2′, 3′, &c., will be the ordinates of a linear arch, set off on the corresponding verticals passing through 1 and a, 2 and b, 3 and c, &c. AB might be called the development of the linear arch DA. Now let the curves CI and HK be developed in a similar way, so that, for instance, the ordinates measured from a to these curves are equal to the ordinates measured on the vertical passing through 1′ from DB to the developments $I_1 G_1$ and $H_1 K_1$; then it is clear that for the given loads any linear arch which lies within the middle third of the ring must, when developed, be represented by a straight line lying within the area $I_1 G_1 H_1 K_1$, and consequently that the straight line BC, which starts from the lowest point B in this area, and is tangent to the curve $G_1 I_1$, will be the development of the curve of

maximum rise and minimum thrust which can be drawn within the given middle third with the given loads. The line BC determines the point C, and the ordinates of BC give the ordinates of the curve DC, the ordinates being measured on corresponding verticals.

The example shown is the diagram for an arch of 52 feet span and 10 feet 4 inches rise, the depth of the ring at the crown being 2 feet 6 inches, and at the springing 3 feet 8 inches. The loads per foot of breadth, beginning at a, are—23·04, 19·45, 16·35, 13·94, 12·01, 10·35, 8·98, 7·93, 6·32, 5·79, 5·52, 5·39 cwts. The rise of the linear arch found is 10·2 feet, and h per foot of breadth of the arch 129 cwt. $= \frac{1315 \text{ ft. cwt.}}{10 \cdot 2 \text{ ft.}}$

§ 43. *Empirical Expression for the Thickness of the Ring.*—The ring when not of equal thickness is always made of least depth at the crown. The depth of the key stone is therefore the thickness of the ring at its smallest part.

Let D be this depth in feet, and r the radius of the arch in feet at the crown. Then we may take (Trautwine)—

1. . . . . $D = C\sqrt{r}$.

According to Rankine, C may be taken as ·346 for a single arch, and ·413 for one of a series of arches. The reason for making one of a series thicker than a single arch is, that the former has, when not loaded itself, to bear part of the thrust from its neighbours when these are loaded; this thrust tends to throw the linear arch in the unloaded span low down in the keystone. The following is another series of values of C in practical use:—

For first class stonework ....C = ·36
,, second class stonework.................. ......C = ·4
,, brick and rubble......................... ....C = ·45

Perronet gives the following rule:—Let L be the span in feet—

2. . . . . $D = 1 + \frac{L}{30}$.

Rankine, *Civil Engineering*, p. 427, shows that Trautwine's rule is rational. Perronet's can only be so when the usual proportion of rise to span is adopted.

Brickwork arches of 24 feet span and less are made 1 foot 6 inches deep at the crown; 30 feet span, 1 foot 10½ inches; 40 feet span, 2 feet 3 inches. The usual flat arch of these dimensions has its ring increased by two rings of bricks towards the haunches. These do not show on the face being concealed by the spandrils. Rubble arches are made a little thicker.

§ 44. *Practical Details.*—The strongest and simplest form of arch is a flat circular arc, having a rise of about one quarter of the span. In these arches the springing is above the place where the joint of rupture would occur if the ring were prolonged. Those parts of an elliptical or semicircular arch which lie below the joint C, fig. 49, are of use chiefly to improve the appearance of the arch. They are virtually part of the abutment, which is sometimes even considered as extending to the joint B. In a very flat arch the linear arch may be brought to coincide more truly with the axis of the ring by lightening the haunch, with which object the roadway is sometimes carried on small flat arches turned at right angles to the main arch, and having the spandrils of the main arch as abutments.

The joints between the voussoirs should be very evenly worked, so that the pressure may be evenly distributed. In brick joints the layers of mortar should be thin. Great care should be taken to provide for the drainage of the roadway above the arch. With this object the masonry should be covered with a sheet of asphalt sloping down to the piers or abutments, and suitable drains must be provided to collect the water and discharge it through the pier or abutment.

SKEW ARCHES have already been treated of under the general head ARCH (vol. ii. p. 330).

Considerable attention must be given to the construction of the *centres* or wooden frames on which the voussoirs rest while the ring is in process of being built. Extreme rigidity is necessary, and this rigidity is best attained by adopting one of the three following plans (Rankine):—1. Direct supports as in fig. 53, illustrating Hartley's centre for the bridge over the Dee at Chester (total span 200 feet); 2. Inclined struts in pairs as shown in fig. 54, being a diagram of the centre used in the erection of Waterloo Bridge; 3. Trussed wooden girders, of which an example is afforded by the truss used in the erection of London Bridge, fig. 55.

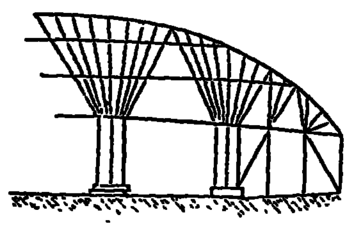


Fig. 53.

Figure 55 shows the *striking plates* and *wedges* by which the centre is lowered after the completion of the arch. The upper and lower plates A and B are strong

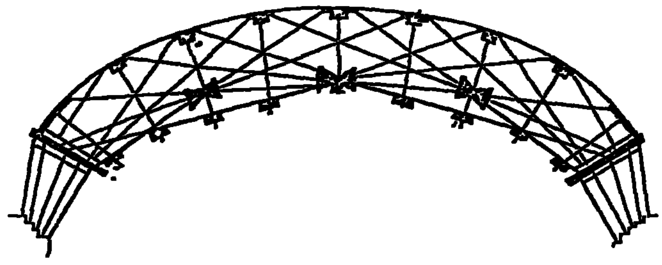


Fig. 54.

beams suitably notched, and are separated by the compound wedge C; this wedge is kept in its place by cross wedges shown in section in the figure. When the centre

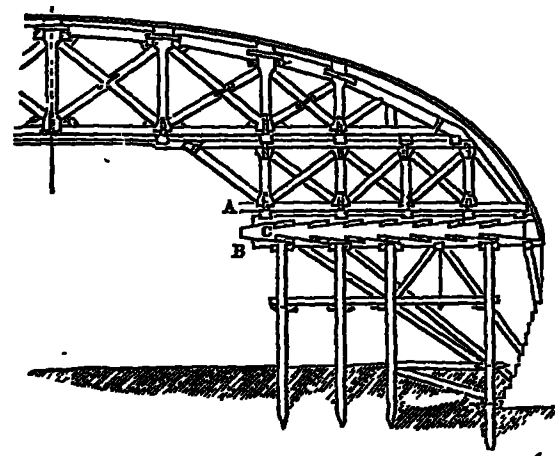


Fig. 55.

is to be lowered these cross wedges are knocked out, and the main wedge C driven back. Owing to defective centering some large French arches sank much during construction, and owing partly to this cause, and partly, as it would appear, to defective mason-work, the total deformation after the centres had been struck was most extraordinary. In Perronet's bridge at Neuilly (*vide* Table XVII., § 84) the sinking, while the centre was in its place, amounted to 13 inches, and after the centre was struck a further sinking took place of 9½ inches. The crown of the centering had a radius of 150 feet, but the sinking of the arch was such that for 60 feet it assumed the form of an arc of a circle with a radius of 244 feet. It is remarkable that the bridge, built in 1774, of very bold design and so imperfectly executed, still stands. When the centres of Waterloo Bridge were removed no arch sank more than 1½ inches. Centres have occasionally been supported on strong sacks full of sand. To lower the centre the sand was allowed to escape through apertures in the sack. It is believed that this method was first employed by a French engineer, M. Beaudemoulin. The canvas sack has been advantageously replaced by wrought iron

boxes or troughs; the block supporting the centre acts as a lid resting on the sand inside; when the sand is allowed to escape the block sinks slowly down inside the box.

§ 45. *Comparison of Metal with Masonry Arches.*—Metal arched ribs may be used instead of rings of masonry to support a platform and roadway. These arched ribs constitute true arches whenever, as is generally the case, all parts of the rib are compressed. The principles by which the stress on each part may be computed do not differ from those already explained for arches of masonry, but it is possible to calculate the stresses with much greater exactitude for continuous metal ribs than for voussoirs. With voussoirs we have seen that the resultant thrust at the springing is indeterminate both in magnitude and position, but we shall see hereafter that the resultant thrust, which will be called t, at the springing of a metal arch is easily rendered determinate. Supposing t and t_1, the thrusts due to a given load (fig. 56), to be known, then if the form of rib be made to

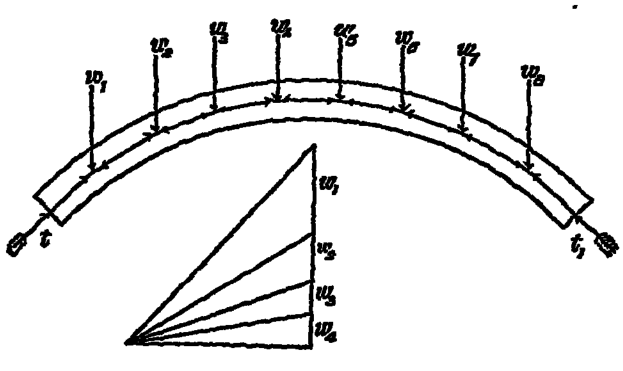


Fig. 56.

correspond with any linear arch for the given distribution the compression at any section of the rib will be axial and uniformly distributed; the arch will then be strained as a chain of the same length would be strained under the same distribution of loads, extension being substituted for compression and dip for rise. Fig. 56 shows a rib of this kind with the approximate linear arch drawn as an equilibrated polygon by the method explained in § 38.

If the distribution of the load is altered the linear arch will also change, and the stress on each part of the rib will no longer be axial. The change in the form of the linear arch will generally be much greater for a metal than for a masonry arch, because most metal arches have light open spandrils and a light roadway, so that the passing load is considerable in comparison with the permanent load. Not improbably the linear arch, when only one haunch of a metal rib is loaded, may pass quite outside the rib for a portion of its length if this rib is made, as is usually the case, of a form containing the linear arch for a symmetrically distributed load. On the other hand, it does not follow, as with masonry, that because the linear arch passes outside the rib the bridge will fail. The bending couple then produced can be resisted by the moment of the elastic forces of the cross section of the rib if the rib is made strong enough. In masonry the joints open so soon as the resultant pressure passes outside the middle third of the ring; the couple required to produce equilibrium would then require a negative force or tension at the opposite edge, and masonry cannot supply this tension, but in a metal rib the couple or bending moment produced by the excentricity of the stress may be resisted by the stiffness of the rib acting as a beam subject to a bending moment. Thus the strength of an arch to resist flexure is a more important element in the metal rib than in the masonry structure. It would be false to say that the ring of voussoirs had *no strength* to resist flexure, for we have on the contrary seen that the moment of the elastic forces at any section of a stone ring does resist any distorting action produced by the load; but in masonry this moment should never exceed the comparatively small value consistent with the absence of tension on any part of any joint. The metal rib may with safety be subjected to considerable tension in parts, and its strength to resist flexure can be easily increased and can be calculated with certainty. Moreover, by hinging the rib at one or both springings, as can be done with metal, the problem of determining the horizontal thrust (or total thrust) is simplified, the position of the thrust being thereby rendered certainly axial at this point, and then by taking into account the actual deformation of each part of the rib a complete solution of the problem of its strength can be obtained.

§ 46. *Horizontal Thrust of a Metal Arch or Rib hinged at the Abutments.*—By supporting a rib on pins or in cylindrical bearings (*vide* fig. 62) at the abutments we determine two points traversed by the thrust. The effect of allowing free rotation is necessarily to render the bending moment *nil* round the centre of rotation. Hence the resultant thrust must traverse the centre of the pin, or the centre of curvature of the bearing. Knowing the point of application of the thrust we have now to determine its magnitude. The vertical component v is the same as the load on the pier of a girder of the same span equally and similarly loaded, so that the problem reduces itself to the determination of h the horizontal component.

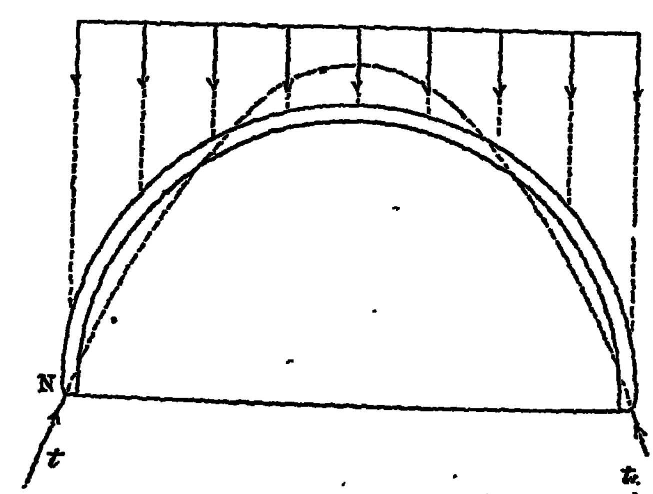


Fig. 57.

Let us first consider a semicircular rib (fig. 57), bearing a load uniformly distributed along the horizontal platform of the bridge (neglecting the weight of the rib). The linear arch will pass through the centre of the bearings N and Q, and will be a parabola. Moreover, it will be that parabola which requires the rib to exert no internal forces due to its own elasticity, and tending either to push out or draw in the springings; in other words, the rib, being supposed in equilibrium before the application of the weights, will not tend to act as a spring to increase or diminish the opening between N and Q. Nevertheless, as the semicircle cannot coincide with the parabola, most parts of the rib must be subject to bending moments, against which it will react as a bent spring. When the linear arch, as shown in fig. 57, passes above the axis of the rib at the crown, and below it at the haunches, the upper portion of the bent rib will act as a spring, tending by its reaction to diminish the distance between the ends N and Q, while the portions near the springing will be so bent as by their reaction to tend to increase that distance; now, if, as is necessarily the case, the whole rib is not to act as a spring, tending either to close or open the ends N and Q, then the effect of the bending near the haunches must exactly neutralize the effect of the bending near the crown. We have now to find what direction of thrust at the springing will give a linear arch such that the above condition may be fulfilled.

Let M be the bending moment acting at any given section, the centre or neutral axis of which is at a height y (fig. 58) above the horizontal line joining the springings; let this moment be considered constant for a short length ΔL of the rib measured axially along the rib; let Δs be the short distance measured horizontally by which the moment M acting throughout the length ΔL would

increase or diminish the span of the rib at the springings, the rest of the rib being assumed free from strain. Then calling I the moment of inertia of the cross section of the rib, and E the modulus of elasticity, we shall have—

1. . . . . . . $\Delta s = \frac{My.\Delta L}{IE}$,

as appears from the following considerations:—

In fig. 58, let $Oo = Aa = Bb = \Delta L$; conceive the surface at AB as fixed, and let the action of the couple M be such as to extend the

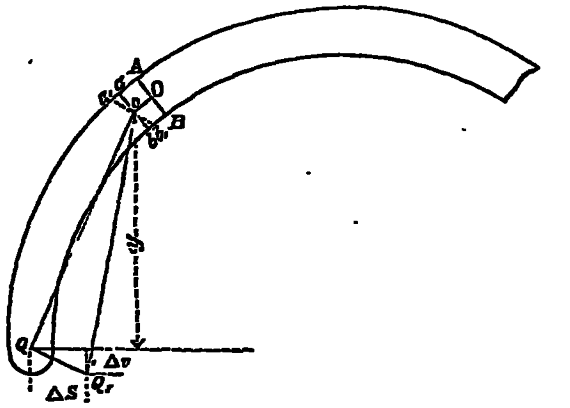


Fig. 58.

top and compress the bottom of the rib, moving the point a to a_1, and the points b to b_1; then, calling p the intensity of the stress at a, we have (equation 4, § 14)—

$$M = \frac{2p_1 I}{d};$$

also we have (§ 24)—

$$aa_1 = \frac{p_1 \Delta L}{E};$$

and therefore—

$$aa_1 = \frac{M\Delta L}{EI}\frac{d}{2};$$

join o and Q and draw the line oQ_1, making the angle QoQ_1 equal to aoa_1; at Q draw $\overline{QQ_1}$ perpendicular to $\overline{oQ}$. Then the effect of the couple M on the length ΔL of the rib, the rest being unstrained, will be to move the point Q to Q_1, and by similar triangles we have—

$$\overline{aa_1} : \overline{QQ_1} = \frac{d}{2} : \overline{oQ};$$

and therefore—

$$\overline{QQ_1} = \frac{M.\Delta L}{E.I}.\overline{oQ}.$$

Then resolving the motion $\overline{QQ_1}$ into horizontal and vertical components Δs and Δv, we have by similar triangles, $\Delta s : QQ_1 = y : oQ$, or, as above—

$$\Delta s = \frac{My.\Delta L}{I.E}.$$

But if, as above stated, the rib does not act as a spring in either direction, the span will remain constant, and the sum of all the changes in span produced by all the successive lengths ΔL will be *nil*, or $\Sigma \Delta s = 0$. Hence, since E is constant, we have

2. . . . . . . $\Sigma \frac{My.\Delta L}{I} = 0$

as a necessary condition for the equilibrium of a loaded rib, hinged at the abutments when these do not yield. This condition must be satisfied whatever be the form or load of the rib, the reasoning by which it was obtained being independent of the form either of the rib or linear arch. When the cross section of the rib is constant, we have—

3. . . . . . . $\Sigma My.\Delta L = 0$.

We shall now proceed to show how the linear arch satisfying this condition can be found for the case of a uniform rib.

Let the line $OO_1O_2O_3O_4$, fig. 59, be the geometrical axis of the rib, and let $OC_1C_2C_3C_4$ be the linear arch required; this arch will, as shown above, cut the geometrical axis at some point, as at O_3.

Let $\overline{C_4C}$ represent the resultant pressure on the rib at any point C_4 in direction and magnitude, fig. 60. If this pressure be resolved into its vertical and horizontal components, the latter $\overline{C_4H}$ will be equal to the horizontal thrust h (constant throughout the linear arch since the loads are vertical).

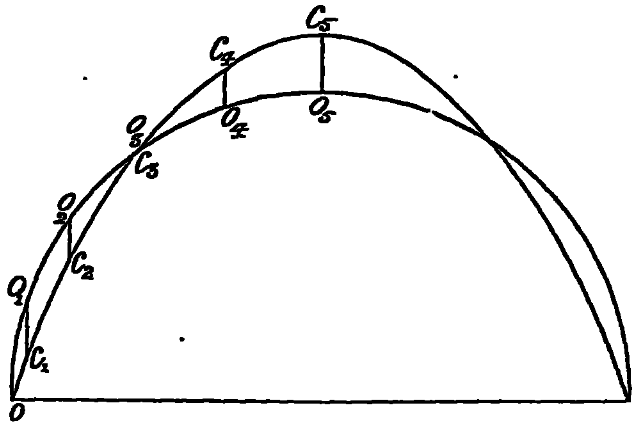


Fig. 59.

This force applied at C_4 will be equivalent to an equal and parallel force, $O_4H_{,,}$, applied at the point, O_4 in the axis, added to a left handed couple, of which the moment is $h\ \overline{O_4C_4}$. This couple

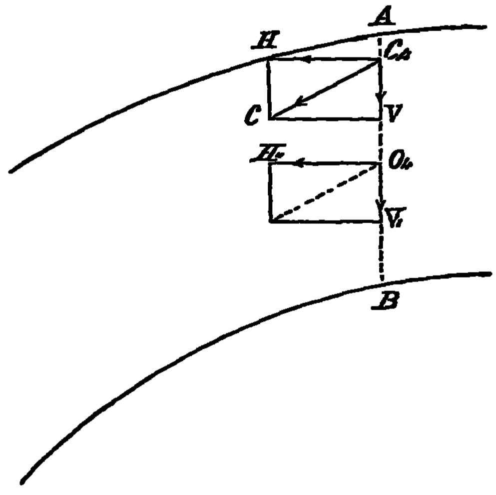


Fig. 60.

is, for the point O_4, the couple M* required for equations 1, 2, and 3, the magnitude of which, h being constant, is proportional to the vertical distance OC between the curves at any point. Equation 3 requires that the sum of all the values of My shall be equal to zero, and we now see that this condition results when the sum of all the products of OC into y is equal to zero, or when—

4. . . . . $\Sigma y.OC = 0$;

when the cross section is not constant the value of $\frac{y.OC}{I}$ must be substituted for the simple product $y.OC$.

The problem of discovering the actual linear arch which will be called into play with a given rib is now reduced to that of finding the linear arch fulfilling the condition in equation 4. We might proceed tentatively, drawing numerous linear arches, and selecting by trial that which most nearly fulfils the condition, as proposed by Mr Bell, *Proc. I.C.E.*, vol. xxxii., but Professor Fuller of Belfast has shown, *Proc. I.C.E.*, vol. xl., that the ordinates of the required linear arch can at once be calculated from the values of the bending moment at the several sections of a beam of equal span and similarly loaded. Let $og_1g_2g_3$ (fig. 61), be the curve of bending moments which, as was shown in § 30, is one form of linear arch corresponding to the given load, the lengths $\overline{oo_1}$, $\overline{o_1o_2}$, $\overline{o_2o_3}$ &c., being equal and representing ΔL; let y as before be any ordinate of the curve $oo_1o_2o_3$, the axis of the rib; let $\overline{sg}$ be any ordinate of the given curve of bending moments; let $\overline{sc}$ be any ordinate of the required linear arch. Then, since $\overline{oc} = \overline{sc} - y$, we have for the case of uniform cross section and hinged abutments the equation—

5. . . . . $\Sigma y(\overline{sc} - y) = 0$, or $\Sigma y.\overline{sc} = \Sigma y^2$;

* This couple is sufficient to shift the force from C_4 to O_4, but the resultant of the force at C_4 and the couple would not be tangent to the geometrical axis of the rib. To alter the direction of the force in this manner a vertical component must be added, but this vertical component may be looked upon as a shearing force, which, being vertical, tends neither to extend nor to diminish the span.

but the ratio $\overline{sc} : \overline{sg}$ is constant, and may be designated by the letter k; so that we may write $k\,(\Sigma y.\,\overline{sg}) = \Sigma y^2$, from which equation we find the value of k—

$$6. \quad \ldots\ldots\ldots \quad k = \frac{\Sigma y^2}{\Sigma y.\,\overline{sg}}.$$

If the cross section is not constant we have for k the more complex expression—

$$7. \quad \ldots\ldots\ldots \quad k = \frac{\Sigma \frac{y^2}{I}}{\Sigma \frac{y.\,\overline{sg}}{I}};$$

but $\overline{sc} = k.\overline{sg}$, so that the required ordinate sc is at once obtained in terms of k and the known ordinate $\overline{sg}$.

When the actual linear arch $oc_1c_2c_3$, &c., has been thus obtained, it is easy to calculate the horizontal thrust; for let $\overline{s_5c_5}$ be the maximum ordinate, the direction of the thrust will at this point of the curve be horizontal, and therefore calling W the weight on one side of this ordinate, and x the distance of its centre of gravity from the springing, we have—

$$8. \quad \ldots\ldots\ldots \quad Wx = h.\overline{s_5c_5},$$

from which h can be found.

h and v being known give the position and direction of the resultant thrust at the springing of the rib. The magnitude of the thrust at any other point is easily computed graphically or by moments

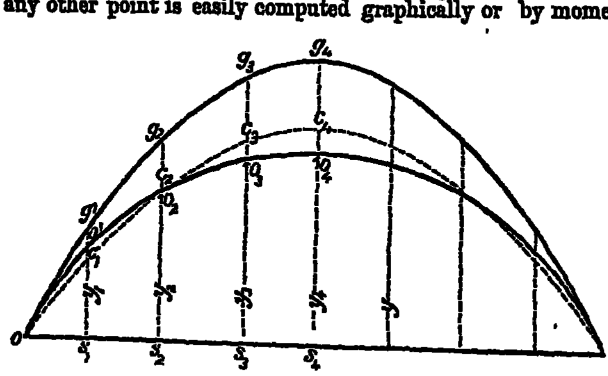


Fig. 61.

round the springing; then the resultant thrust at a given point being known, the intensity of the stress on any part of a section at that point is to be computed by first resolving the thrust into two components, one normal to the section and one in the plane of the section; the latter gives rise to a shearing stress (analogous to the force which causes one stone to slip on another in the masonry arch), while the component normal to the section will (if not axial) give rise to a uniformly varying stress, the magnitude of which at each distance from the axis can be computed by the formulæ given in § 8.

The value of h is determinate, if the direction of the rib be supposed fixed at the springing, but this cannot be ensured in large structures, and the theory need not therefore be developed. It simply requires $\Sigma\, co = 0$.

When the rib (as is generally the case in existing bridges) abuts against a flat springing the exact value of h is indeterminate. When the rib is hinged the friction at the bearing renders the thrust indeterminate within limits depending on the possible bending moment at the springing due to the friction.

§ 47. *Process of Designing a Rib.*—In future designs of ribbed arches it is to be hoped that the practice will be adopted of allowing the rib freedom to turn at the springing. This can be done by ending the rib in a bearing, curved as in fig. 62; the resultant thrust will then be approximately axial, and the stress on every part of the rib can be determined with as much accuracy as on the several parts of a girder. When the span is large a cast-iron metal arch can be made lighter than a wrought iron girder for the same load, but the imperfection of the theory of the stresses on the ribs has hitherto led to great waste of metal in their construction. In what follows it is assumed that the resultant at the springing passes through the geometrical centre of the cross section of the rib.

If the rib were to carry a load distributed only in one way we ought clearly to make the form of the axis of the rib coincide with a linear arch for that load. There would then be no bending moment on any part of the rib. As in practice we must provide for all the possible combinations of passing load, we need take little pains in designing the curvature of the rib—a flat arc of a circle with a rise of say $\frac{1}{8}$th will answer well. The semicircular or elliptical forms are not good, for no linear arch with any practical distribution of load can even approximately coincide with a form in which the rib springs vertically from the abutments.

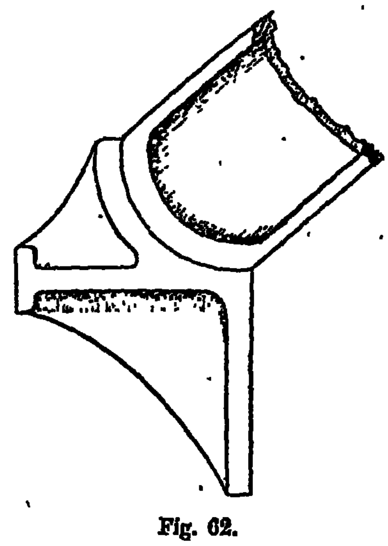


Fig. 62.

The general character of the cross section should be similar to that for a girder, inasmuch as the rib will have to resist bending moments as well as direct compression. The depth need not, however, be nearly so great as the depth of a girder. Let a cross section be chosen in which the area is assumed as approximately say 5 per cent. more than that which would be sufficient to sustain the thrust resulting from a linear arch suitable for the maximum load and coinciding approximately with the axis of the rib. (If the load be nearly uniform per foot run of platform we may for this first approximation take $h = \frac{wl^2}{8d}$, where d is the rise of the linear arch above the springings.) With the rib thus designed determine by the method given in § 46 the actual linear arches resulting from the following arrangements of passing load (combined with the permanent load):—(1), Bridge half covered from one end; (2), three-quarters covered from one end; (3), wholly covered; (4), covered by the passing load over the middle half of the bridge, the haunches being unloaded. Draw these linear arches on the rib by the method given in § 38, and choosing at each one of some eight or ten selected sections the two curves which most nearly approach the top and bottom flanges respectively, compute the maximum intensity of stress on the top and bottom flanges at each section from the two thrusts corresponding to these two linear arches; where the stress is excessive add metal; remove it where the maximum stress is less than the safe stress for the material. If no great change is made in the design this process will be sufficient, but if the cross section is seriously modified by the alteration we must make a second approximation by recalculating the linear arches for the new form of rib, and thus proceed by trial and error until the stresses corresponding to the actual linear arches are met by sufficient metal at all points. The rib need not be of uniform depth throughout, and may be increased in depth at the places where the stress due to bending moment has been found excessive.

In large spans the effect of a change of temperature must be taken into account. This can be done by finding the linear arch given by the expression—

$$1. \quad \ldots\ldots \quad \Sigma \frac{M\Delta l}{I} y = \Delta s,$$

where Δs is the alteration in span which would result from the expansion or contraction of the span if free to expand or contract with the change of temperature.

In a series of arches abutting against comparatively slender piers, account must be taken of the thrust transmitted from the neighbouring arch. This thrust will only be due to the passing load, and a part may be considered as taken by the pier; the remainder which the

pier cannot counterbalance must be compounded with the reaction due to the linear arch calculated for the permanent load of the unloaded span. With the reaction thus computed the linear arch resulting in the unloaded span must be constructed, and the stresses examined on the top and bottom flanges of the rib.

The theory now given for a stiff rib used as an arch is equally applicable to a stiff rib hung as a suspension bridge.

§ 48. *Wooden Arches.*—Arches have occasionally been built of wood with ribs elaborately constructed of bent timber, scarfed and bolted together; the strength of such a rib could be calculated in the way indicated for metal ribs, but the mode of construction is not to be recommended. When wood is employed it should be used in simple straight balks built into a framed arch.

§ 49. *Practical Details of Metal Arches.*—The common form of metal arch is a cast-iron rib of I section and of small depth. This rib is intended to be sufficient, unaided, to bear the whole weight of the superstructure. The spandrils, made of some kind of lattice work (or occasionally a mere arcade), bear the roadway, and to some extent stiffen the rib beneath. The rib may with advantage be made much deeper than has been the practice, and may consist of tubes framed as in the St Louis Bridge, fig. 5, Plate XVIII., so as to form a single stiff rib. Where, to gain headway, a rib of small depth at the crown is desirable, the rib might with advantage be deepened at the haunches. Wrought iron is a very suitable material for small arches, where the permanent load is insufficient to prevent tension from occurring in some parts of the rib. Cast-iron and cast-steel are better materials for large spans; for moderate spans a good form of metal arch will be shown under the head of "Frames" (fig. 77), being that in which a lower member is braced to the upper member carrying the roadway so as to form a true frame; for very large spans a single deep rib, or a frame with parallel members arranged as an arch, may be adopted. This design has the advantage over that shown in fig. 77 of avoiding very long bracing at the abutments.

V. Frames.

§ 50. *Preliminary.*—A frame is a rigid structure composed of straight struts and ties. The struts and ties are called the members or pieces of the frame. The frame as a whole may be subject to a bending moment, but each bar, pillar, rod, or cord in the structure is thereby simply extended or compressed so that the total stress on a given member is the same at all its cross sections, while the intensity of stress is uniform for all the parts of any one cross section. This result must follow in any frame, the members of which are so connected that the joints offer little or no resistance to change in the relative angular position of the members. Thus if the members are pinned together, the joint consisting of a single circular pin, the centre of which lies in the axis of the piece, it is clear that the direction of the only stress which can be transmitted from pin to pin will coincide with this axis. The axis becomes, therefore, a line of resistance, and in reasoning of the stresses on frames we may treat the frame as consisting of simple straight lines from joint to joint. When the members of a frame consist of iron rods as ties, combined with struts formed by angle iron or T iron of the usual sizes, or by pieces of timber of the ordinary dimensions, it is found by experiment that the stresses on the several members do not differ sensibly whether these members are pinned together with a single pin or rigidly jointed by several bolts or rivets. Frames are much used as girders, and they also give useful designs for suspension and arched bridges. A frame used to support a weight is often called a *truss;* the stresses on the various members of a truss can be computed for any given load with greater accuracy than the intensity of stress on the various parts of a continuous structure such as a tubular girder, or the rib of an arch. Many assumptions are made in treating of the flexure of a continuous structure which are not strictly true; no assumption is made in determining the stresses on a frame, except that the joints are flexible, and that the frame shall be so stiff as not sensibly to alter in form under the load. Both assumptions are consistent with the facts in the case of any bridge truss.

§ 51. *Classes of Frames used as Trusses.*—Frames used as bridge trusses should never be designed so that the elongation or compression of one member can elongate or compress any other member. An example will serve to make the meaning of this limitation clearer. Let a frame consist of the five members AB, BD, DC, CA, CB (fig. 63), jointed at the points A, B, C, and D, and all capable of resisting tension and compression. This frame will be *rigid, i.e.*, it cannot be distorted without causing an alteration in the length of one or more of the members; but if from a change of temperature or any other cause one or all of the members change their length, this will not produce a stress on any member, but will merely cause a change in the form of the frame. Such a frame as this cannot be *self-strained.* A workman, for instance, cannot produce a stress on one member by making some other member of a wrong length. Any error of this kind will merely affect the form of the frame; if, however, another member be introduced between A and D, then if BC be shortened AD will be strained so as to extend it, and the four other members will be compressed; if CB is lengthened AD will thereby be compressed, and the four other members extended; if the workman does not make CB and AD of exactly the right length they and all the members will be permanently strained. These stresses will be unknown quantities, which the designer cannot take into account, and such a combination ought therefore never to be adopted. A frame of this second type is said to have one *redundant member.*

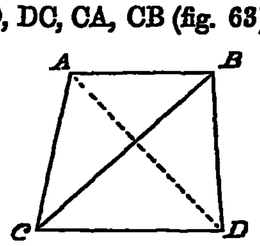


Fig. 63.

If the members AD and CB were flexible cords there would be no redundant members; for the tightening of one diagonal would throw no sensible stress on the other diagonal, since it is supposed incapable of resisting a thrust. Both diagonals, if flexible, are required to prevent the quadrilateral from getting out of shape. Members capable of bearing only one kind of strain might receive the name of *semi-members.*

§ 52. *External Forces on Frame.*—Frames used as bridge trusses are in equilibrium under the external forces applied to them. These forces are—(1) the loads, (2) the reactions at the points of support. The loads are to be referred to the joints as follows:—(1) find the resultant of the load carried by any two joints; (2) resolve that load into two vertical components acting through the two joints; (3) compound the several components acting at each joint into one resultant. This process gives a frame with external forces equivalent to the actual loads, but acting only at the joints. The frames are always supported at a joint, and the reactions of the supports are therefore also forces acting at joints. The load between any two joints is directly supported by the member of the frame joining them; the stresses due to the direct action of this partial load must, where great accuracy is wanted, be added to the stresses computed on the assumption that the loads have been applied directly to the joints. Generally the stresses due to the direct action of the load between two joints may

be neglected except where a member of the frame is employed to carry the roadway.

Fig. 64 shows a common form of bridge truss known as

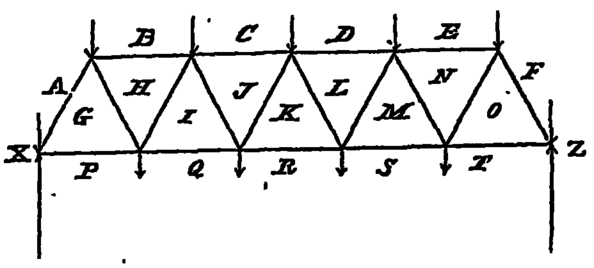


Fig. 64.

a *Warren girder*, with lines indicating external forces applied to the joints; half the load carried between the two lower joints next the piers on either side is directly carried by the abutments. The sum of the two upward vertical reactions must clearly be equal to the sum of the loads. The lines in the diagram represent the directions of a series of forces which must all be in equilibrium; these lines may, for an object to be explained in the next paragraph, be conveniently named by the letters in the spaces which they separate instead of by the method usually employed in geometry. Thus we shall call the first inclined line on the left hand the line AG, the line representing the first force on the top left hand joint AB, the first horizontal member at the top left hand the line BH, &c.; similarly each point requires at least three letters to denote it; the top first left hand joint may be called ABHG, being the point where these four spaces meet. In this method of lettering, every enclosed space must be designated by a letter; all external forces must be represented by lines *outside* the frame, and each space between any two forces must receive a distinctive letter; this method of lettering was first proposed by Mr R. H. Bow (*Economics of Construction*), and is convenient in applying the theory of reciprocal figures to the computation of stresses on frames.

When the weight of the truss is small it is usual to refer the weights of the parts of the truss itself to the same joints as carry the roadway, and to treat all other joints as unloaded.

The reactions at the points of supports of a framed arch or suspension bridge are inclined, as in fig. 65; the manner

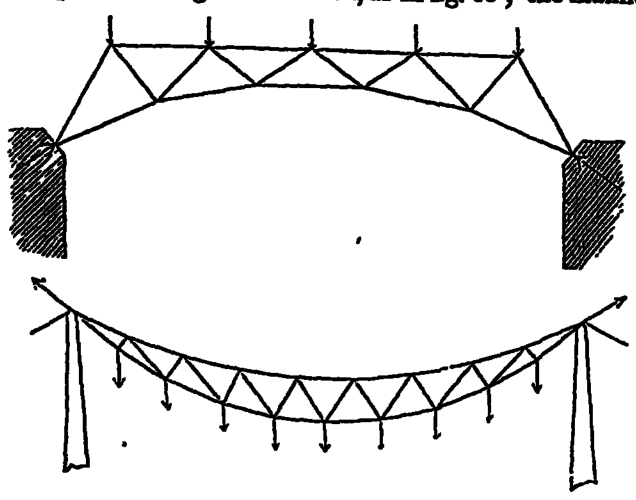


Fig. 65.

of computing the stresses on these frames when the direction of these reactions is known will be first explained, and subsequently the manner of finding this direction will be given.

§ 53. *Reciprocal Figures.*—Prof. Clerk Maxwell has given (*Phil. Mag.* 1864), the following definition of reciprocal figures:—"Two plane figures are reciprocal when they consist of an equal number of lines so that corresponding lines in the two figures are parallel, and corresponding lines which converge to a point in one figure form a closed polygon in the other."

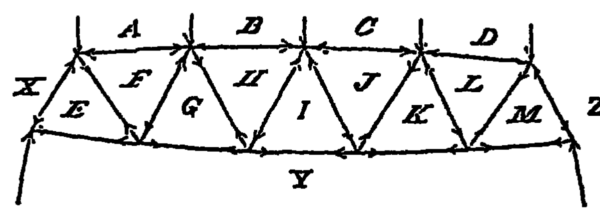
Let a frame (without redundant members), and the external forces which keep it in equilibrium, be represented by a diagram constituting one of these two plane figures, then the lines in the other plane figure or the reciprocal will represent in direction and magnitude the forces between the joints of the frame, and, consequently, the stress on each member as will now be explained.

Reciprocal figures are easily drawn by following definite rules, and afford therefore a simple method of computing the stresses on members of a frame.

The external forces on a frame or bridge in equilibrium under those forces may, by a well-known proposition in statics, be represented by a closed polygon, each side of which is parallel to one force, and represents the force in magnitude as well as in direction. The sides of the polygon may be arranged in any order, provided care is taken so to draw them that in passing round the polygon in one direction this direction may for each side correspond to the direction of the force which it represents.

This polygon of forces may, by a slight extension of the above definition, be called the *reciprocal figure* of the external forces, if the sides are arranged in the same order as that of the joints on which they act, so that if the joints and forces be numbered 1, 2, 3, 4, &c., passing round the outside of the frame in one direction, and returning at last to joint 1, then in the polygon the side representing the force 2 will be next the side representing the force 1, and will be followed by the side representing the force 3, and so forth. This polygon falls under the definition of a reciprocal figure given by Clerk Maxwell, if we consider the frame as a point in equilibrium under the external forces.

Fig. 66.



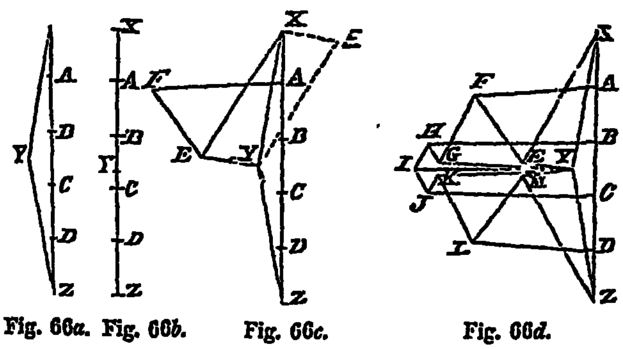


Fig. 66*a*. Fig. 66*b*. Fig. 66*c*. Fig. 66*d*.

Fig. 66 shows a frame supported at the two end joints, and loaded at each top joint. The loads and the supporting forces are indicated by arrows. Fig. 66*a* shows the reciprocal figure or polygon for the external forces on the assumption that the reactions are slightly inclined. The lines in fig. 66*a*, lettered in the usual manner, correspond to the forces indicated by arrows in fig. 66, and lettered according to Mr Bow's method. When all the forces are vertical, as will be the case in girders, the polygon of external forces will be reduced to two straight lines, fig. 66*b*, superimposed and divided so that the length AX represents the load AX, the length AB the load AB, the length YX the reaction YX, and so forth. The line XZ consists of a series of lengths, as XA, AB......DZ, representing the loads taken in their order. In subsequent diagrams the two reaction lines will, for the sake of clearness, be drawn as if slightly inclined to the vertical (as practised by Mr Bow).

If there are no redundant members in the frame, there will be only two members abutting at the point of support, for these two members will be sufficient to balance the reaction, whatever its direction may be; we can therefore draw two triangles, each having as one side the reaction YX, and having the two other sides parallel to these two members; each of these triangles will represent a polygon of forces in equilibrium at the point of support. Of these two triangles, shown in fig. 66*c*, select that in which the letters X and Y are so placed that (naming the apex of the triangle E) the lines XE and YE are the lines parallel to the two members of the

same name in the frame (fig. 66). Then the triangle YXE is the reciprocal figure of the three lines YX, XE, EY in the frame, and represents the three forces in equilibrium at the point YXE of the frame. The direction of YX, being a thrust upwards, shows the direction in which we must go round the triangle YXE to find the direction of the two other forces; doing this we find that the force XE must act down towards the point YXE, and the force EY away from the same point. Putting arrows on the frame diagram to indicate the direction of the forces, we see that the member EY must pull and therefore act as a tie, and that the member XE must push and act as a strut. Passing to the point XEFA we find two known forces, the load XA acting downwards, and a push from the strut XE, which, being in compression, must push at both ends, as indicated by the arrow, fig. 66. The directions and magnitudes of these two forces are already drawn (fig. 66*a*) in a fitting position to represent part of the polygon of forces at *XEFA*; beginning with the upward thrust EX, continuing down XA, and drawing AF parallel to AF in the frame we complete the polygon by drawing EF parallel to EF in the frame. The point F is determined by the intersection of the two lines, one beginning at A, and the other at E. We then have the polygon of forces EXAF, the reciprocal figure of the lines meeting at that point in the frame, and representing the forces at the point EXAF; the direction of the forces on EX and XA being known determines the direction of the forces due to the elastic reaction of the members AF and EF, showing AF to push as a strut, while EF is a tie. We have been guided in the selection of the particular quadrilateral adopted by the rule of arranging the order of the sides so that the same letters indicate corresponding sides in the diagram of the frame and its reciprocal. Continuing the construction of the diagram in the same way, we arrive at fig. 66*d* as the complete reciprocal figure of the frame and forces upon it, and we see that each line in the reciprocal figure measures the stress on the corresponding member in the frame, and that the polygon of forces acting at any point, as IJKY, in the frame is represented by a polygon of the same name in the reciprocal figure. The direction of the force in each member is easily ascertained by proceeding in the manner above described. A single known force in a polygon determines the direction of all the others, as these must all correspond with arrows pointing the same way round the polygon. Let the arrows be placed on the frame round each joint, and so as to indicate the direction of each force on that joint; then when two arrows point to one another on the same piece, that piece is a tie; when they point from one another the piece is a strut. It is hardly necessary to say that the forces exerted by the two ends of any one member must be equal and opposite. This method is universally applicable where there are no redundant members. The reciprocal figure for any loaded frame is a complete formula for the stress on every member of a frame of that particular class with loads on given joints. Some examples of these figures will be given, and the reader will easily construct others for himself.

§ 54. *Warren Girders—Reciprocal Figure and Method of Computing Stresses by Method of Sections.*

Case 1. The Warren girder loaded at each top joint, figs. 67 and 67*a*. This diagram differs very slightly from

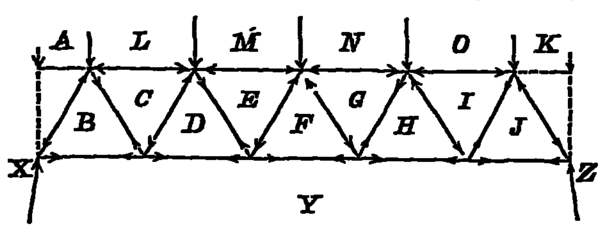


Fig. 67.

that shown in fig. 66. The top and bottom members are in straight lines, and consequently the lines indicating the stresses on the bottom member are superimposed one on the other instead of radiating from Y; the loads XA and FZ are shown as directly borne by the piers. It is clear that if the road is supported by a platform reaching from the end joints to the piers, half of the load on these parts of the platform will be directly supported on the piers. These end loads are shown also in the subsequent diagrams. The truss is generally built of equilateral

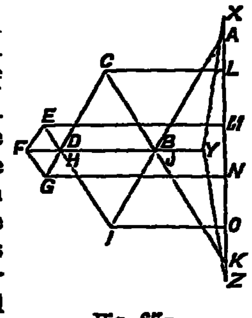


Fig. 67*a*.

triangles, and the inclination of the bracing to the horizon should never be less than 45°.

Case 2. Warren girder loaded on top and bottom, fig. 68. 68*b* shows the polygon of external forces, and 68*c*

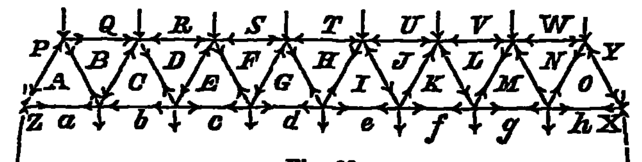


Fig. 68.

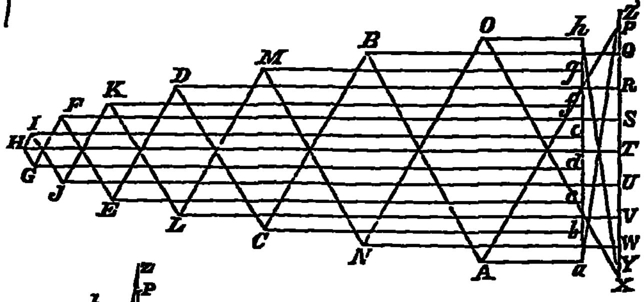


Fig. 68*a*.

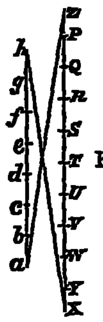


Fig. 68*b*.

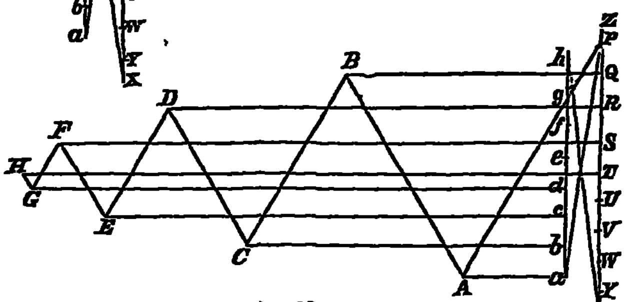


Fig. 68*c*.

shows half the reciprocal figure. These figures have been added to facilitate the comprehension of the complete reciprocal shown by 68*a*

Case 3. Warren girder with one load, not central, fig.

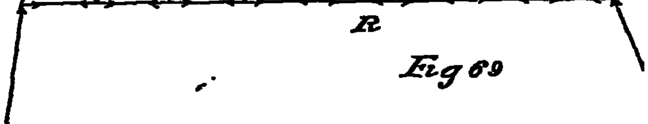


Fig 69

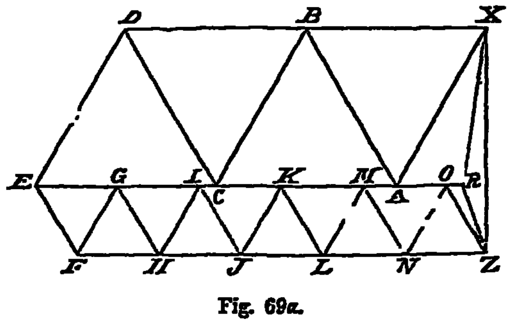


Fig. 69*a*.

69. The polygon RXZ, fig. 69*a*, represents the external forces.

Case 4. Warren girder; *load on half the top joints, fig.* 70.

In designing a Warren girder it is necessary to provide for the advancing load. With a uniformly distributed load the

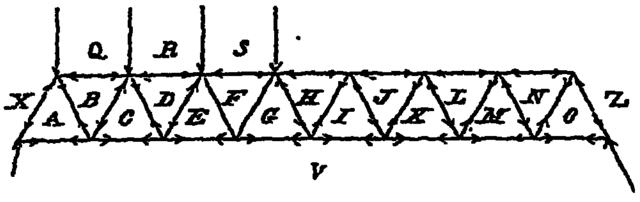


Fig. 70

diagonal bracing consists of alternate struts and *ties* beginning, if supported at the bottom, with a strut at each end, or with the tie at each end if the truss is hung from the top. At the centre there will be either two ties or two struts in juxtaposition; or, as in the case where there are an even number of loaded joints at the top, the central pair of diagonal members

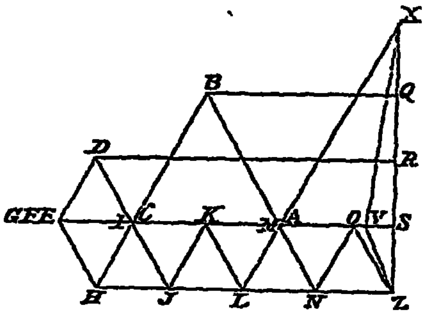


Fig. 70*a*.

will be unstrained; but an advancing load (neglecting the permanent load) will convert each diagonal member (except the end ones) alternately into a *strut* and a *tie*. It is necessary to provide for the maximum extension and maximum compression on each, taking into account the combined effects of the permanent and passing load; the latter has generally sufficient effect to reverse the direction of the stress on the bracing near the centre, but not (in large bridges) towards the ends. Each member of the bracing towards the centre must, therefore, be so designed as to be capable of acting alternately as a strut and as a tie. The maximum stress on the top and bottom members occurs when the bridge is fully loaded.

This stress is easily calculated by the method of sections; assume the girder cut by a vertical plane at the joint or pin opposite the member in question, or in other words, by a vertical plane passing through the vertex of the triangle of which the member in question is the base; let d be the perpendicular distance between the member and the pin, t the thrust or tension on the member, and M the bending moment for the section calculated as for a girder loaded at the points corresponding to the joints. Then $M = td$. The stress on the diagonals corresponds to the shearing stress in the solid girder, and may consequently be calculated from the shearing diagrams, examples of which were given in § 19. The loads may be referred to the joints before drawing the diagram, and the continuous curves of figures 18 to 18*c* will be replaced by lines consisting of a series of steps such as are shown in fig. 18*a*. We may then proceed to calculate the stress on any diagonal as follows:—Take the shearing stress for the section at the joint where the diagonal in question abuts; if there is a load on this joint, take the shearing stress for a section close to the joint, and on that side

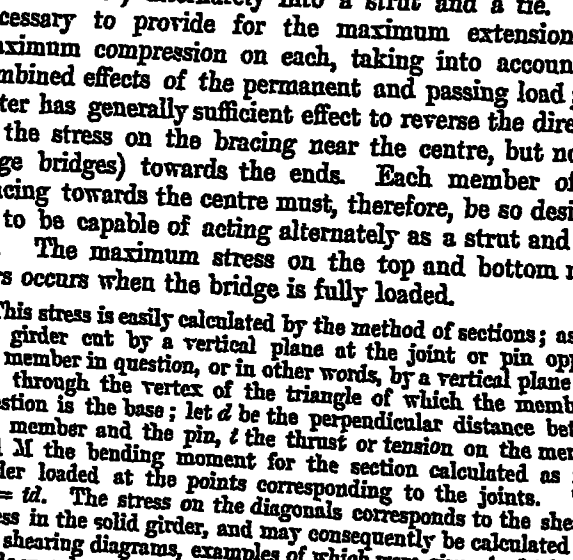


Fig. 71.

of it which is next the diagonal in question; call the shearing force thus found F; let i be the slope of the diagonal or the angle which it makes with the horizon; then the tension or compression on the diagonal is F cosec. i; thus let fig. 71 represent a Warren girder of six equal bays, in which $i = 60°$. Let the load on each top joint be 5 tons, the compressions and tensions on the diagonals are as follows:—

TABLE XI.

Name of Brace.	F × cosec. i.	Compression.	Tension.
1	15×1·1547	17·32	...
2	10×1·1547	...	11·55
3	10×1·1547	11·55	...
4	5×1·1547	...	5·77
5	5×1·1547	5·77	...
6	0×1·1547	...	...

These stresses, given simply as an example, apply to the one special load, and are not to be confounded with *the maximum* stresses which an advancing load of the same intensity would produce. The stresses on the two halves of the girder are symmetrical.

The arithmetical mode of computation is the simpler where the top and bottom members are parallel and the inclination of the diagonals constant; where these conditions are not fulfilled the method by reciprocal figures is preferable.

In the actual design of any girder to suit various combinations of loads, care must be taken to design each member to suit the *maximum* stress which can arise from any combination. The maximum shearing stress is most easily selected by means of the diagrams § 19. Care must be taken to meet both the maximum tension and maximum compression whenever the member is so placed that with some loads it is extended and with some compressed. We have just shown that this case arises in the diagonals near the centre of the girder. When frames are used as continuous girders, it is desirable to make the points of inflection coincide exactly with a joint. This may be done by cutting through or omitting the member opposite the joint. This allows the reactions on each pier to be easily determined by the elementary principles of statics with any load, and without taking into account the form which the beam assumes when deflected. Instead of a long continuous girder, we then have a series of girders, supported at or near the middle of their length by the piers, while a second series hang from the first by pins at determinate points. This arrangement greatly simplifies all the calculations without sensibly diminishing the advantage derived from the use of continuous girders.

§ 55. *Various Forms of Girder.*—The framed girder is sometimes made of the form in fig. 72, which has the

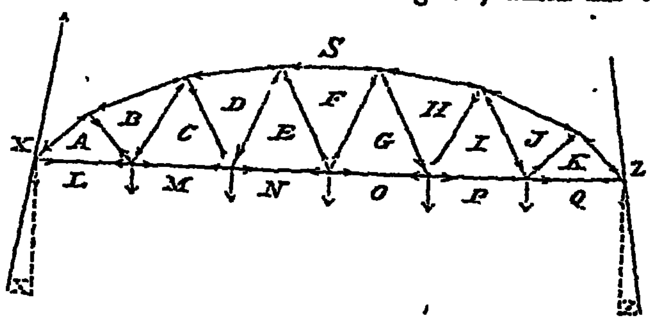


Fig. 72.

advantage of reducing the length of the end diagonals where the stress is heaviest. The reciprocal figure for this truss uniformly loaded on the bottom joints is shown in fig. 72*a*. This girder is sometimes called a bowstring girder, though this name more properly belongs to an obsolete form with no diagonals. Z and X are the spaces between the end loads and the reactions which, for clearness, are shown as pulling up; but the same reciprocal would result if the reaction were shown pushing up, and the letters X and Z were placed as dotted. This

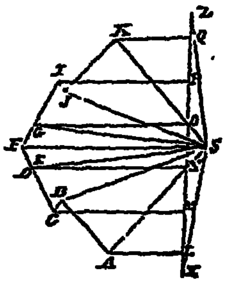


Fig. 72*a*.

form has the advantage of reducing the compression on the diagonal struts to a comparatively small amount. A great part of the shearing stress is taken by the curved upper boom; deeper girders can be profitably used of the bowstring than of the Warren type. The long and expensive struts in the latter form more than counterbalance

the saving to be obtained by increasing the depth beyond about $\frac{1}{12}$th of the span.

The diagonal bracing in the Warren and bowstring girders is sometimes arranged as in fig. 73; the girder is

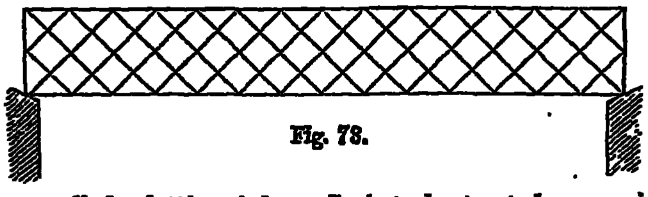


Fig. 73.

then called a lattice-girder. It is to be treated as a series of superposed Warren girders, each bearing its share of the load. This form has a slight advantage inasmuch as the diagonal struts are stiffened by being pinned to the ties where they cross.

Fig. 74 shows a very common and useful form of girder

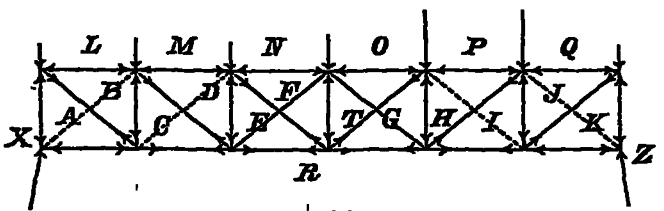


Fig. 74.

where the uprights between the top and bottom members are able to sustain both tension and compression, while the diagonals are only "semi-members," being flexible rods or bars. The reciprocal for this design is shown in fig. 74*a* with two joints more heavily loaded than the others. The members in fig. 74 which have no arrows on them are idle or unused, with this particular distribution of load. When the permanent load is considerable as compared with the passing load, the end or two end diagonals

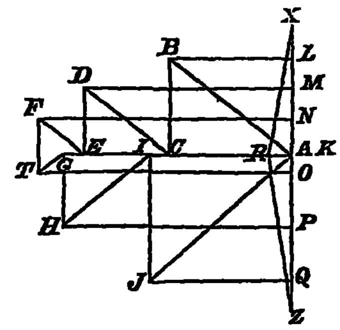


Fig. 74*a*.

shown dotted will not come into action with any distribution of load, and may therefore be omitted. This form is much used when wood is employed for the compression members. It has in every case the advantage that the struts in the bracing are shorter than in the Warren girder. The lettering is arranged so that only those spaces have letters which are divided by members actually in use under this particular load.

Figs. 75 and 75a show a modification of this truss for small spans, and its reciprocal when loaded on one joint;

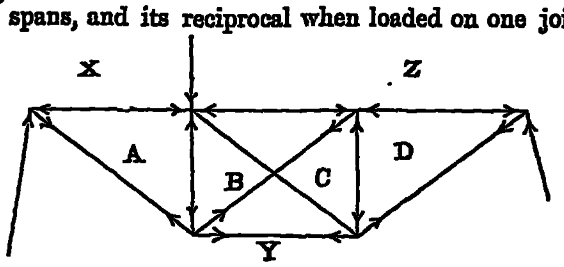


Fig. 75.

the lettering here also only suits the one distribution of load, and the idle members have no arrows on them.

§ 56. *Framed Suspension Bridges and Arches.*—These frames, like the girders, consist of top and bottom members, braced together by ties and struts. The bridge is a suspension bridge, if the frame is supported by inclined forces pulling outwards from the bridge as in fig. 76, and an arch is supported by forces pushing inwards as in fig. 77. The reciprocals of these two forms with the joints at the platform uniformly loaded are annexed. These reciprocals are drawn on the hypothesis that the direction of the thrust or pull is known; and this has been chosen in this case so as to reduce the stress on NG to zero, as would necessarily be the case if NG were omitted or cut. When this is not the case the direction of the thrust or pull at the abutments must be found in the manner explained below.

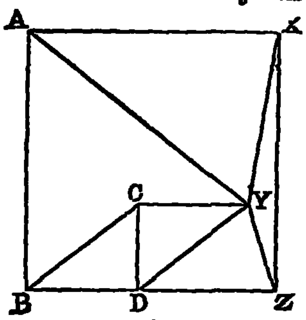


Fig. 75*a*.

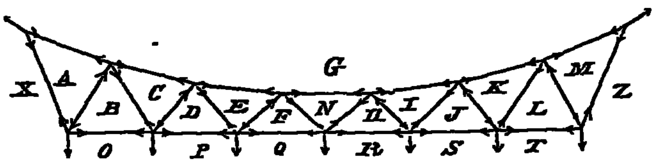


Fig. 76.

It is easy to design the bridge so that both the top and bottom members of the suspension bridge remain in tension, and both those of the arch in compression under all distributions of load. This would allow wire rope to be used for both members of the suspension bridge, and cast-iron or steel for both members of the arch. The stresses on the bracing are very uniform and small as compared with those on the diagonals of a girder.

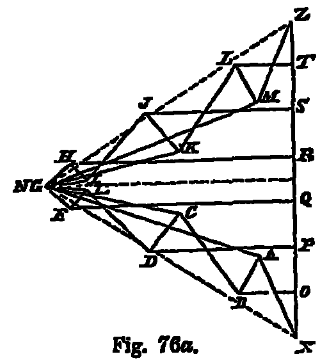


Fig. 76*a*.

Fig. 78 shows a slight modification of the design for a

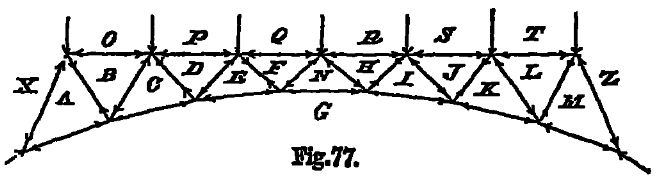


Fig. 77.

suspension bridge, very suitable for spans so large that the end struts in the preceding form would be inconveniently long. The reciprocal annexed is drawn for the case in which a double load is placed on half the bridge. The same design is suitable for an arch.

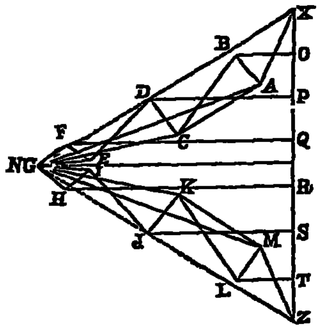


Fig. 77*a*.

The resultant thrust or tension at the supports of framed suspension bridges or arches can only be found by a method analogous to that already explained for the solid metal rib. This method was first given by Prof. Clerk Maxwell.

Consider any member A, fig. 79, of length L and cross-section a, made of a material having the modulus of elasticity E; under the action of a stress F, the length L will be altered by an amount—

$$\Delta L = F\frac{L}{Ea}.$$

Appropriate signs must be given to the arithmetical values of the force and the alteration of length; thus thrust and compression may be called negative, pull and extension positive. If every other member of the frame were absolutely rigid, the span S of the bridge would undergo an alteration ΔS. The ratio $\frac{\Delta S}{\Delta L}$ will depend merely on the geometrical form of the frame; let q be the value of this constant ratio, so that—

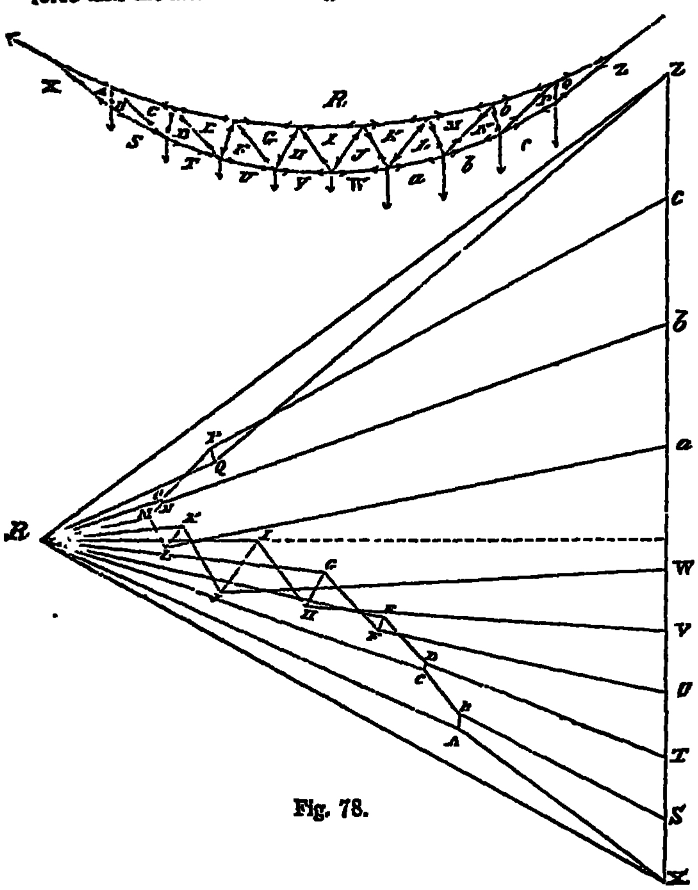


Fig. 78.

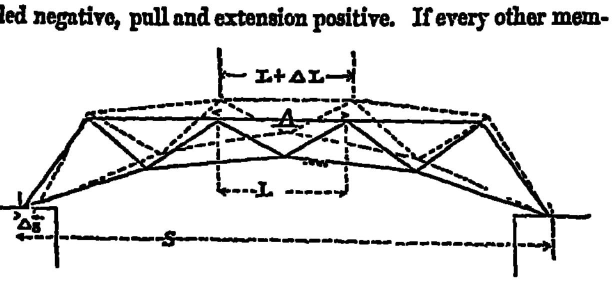


Fig. 79.

$$1. \quad \ldots\ldots \quad \Delta S = q\Delta L = qF\frac{L}{E.a}.$$

Let f be the force produced on the member A by a horizontal force h acting between the springings; then by the principle of virtual velocities we have—

$$f : h = \Delta S : \Delta L,$$

for we may consider the structure merely as a kind of lever, by which the force h exerts a force on A, the fulcrum being the joint opposite A; then the above proportion expresses the fact that the forces h and f are inversely proportional to the spaces which the ends of the lever would move through when a small displacement occurs. Thus we may write

$$f = qh.$$

Similarly let f_1 be the stress which would be produced on A by a vertical force v, applied at one springing, while the other springing was held rigidly so that the whole frame could not turn; the ratio between f_1 and v is constant, depending merely on the form of the frame, so that we may write—

$$f_1 = pv,$$

where p is a constant, to be found in the same manner as q; p may be defined as equal to the whole stress produced on the given member by a unit *vertical* force at the springing, and q as the whole stress produced on the same member by a unit *horizontal* force at the springing, the frame being held rigidly at the opposite abutment.

Then any thrust t at the springing having the vertical and horizontal components v and h will produce a stress F on A, equal to the sum of the stresses of f and f_1, or—

$$F = qh + pv.$$

Substituting this value of F in equation 1 we have—

$$2. \quad \ldots \quad \Delta S = (q^2h + pqv)\left(\frac{L}{Ea}\right) = eq^2h + epqv,$$

where $e = \frac{L}{Ea}$, a constant for each member.

Now, let the values of q, p, and e be calculated for every member of the frame; then, calling the whole elongation $\Sigma\Delta S = k$, we have—

$$k = \Sigma\,(eq^2h + epqv).$$

If the abutments do not yield $k = 0$, and for this case—

$$3. \quad \ldots\ldots \quad h = \frac{\Sigma epqv}{\Sigma eq^2}.$$

v is to be found as for a girder similarly loaded, and t, the required thrust or tension, is the resultant of h and v. The calculation is best made as follows:—Construct tables of the values of d and q for each member of the frame; the method of sections or moments will answer best for the top and bottom members, and that of reciprocal figures for the diagonals; assume a cross section for each member, based on a probable assumed value of t; for the required load make tables of epq and eq^2, or what is equivalent, when E is constant, make tables of the values of $\frac{pq^2}{a}$ and $\frac{q^2L}{a}$. The sum of eq^2 or $\frac{q^2L}{a}$ can then be made. If there be a load on one joint only, find the values of v and v_1, for the right and left abutments, then find $\Sigma epqv$, using the value v for all members to the right of the load, and v_1 for all members to the left of the load; equation 3 will now give the value of h for this single load.

The process of finding $\Sigma epqv$ must be repeated for each joint which is loaded, and the whole horizontal thrust due to the load on any number of joints will be the sum of the separate values of h. When the horizontal thrust is known, the thrusts t and t_1 are obtained at the two abutments by compounding the horizontal thrust with the vertical weight borne at that abutment. When t and t_1 are known, the stresses on each member are to be computed by reciprocal figures or any other convenient method. The process must be repeated for each combination of passing and permanent load, so as to find the maximum stress to which any member can be subjected. If the assumed cross sections are not suitable for these stresses, fresh cross sections must be assumed and the whole calculation repeated. The change in cross section will cause some change in the values of h, but this tentative process need seldom be gone through more than once.

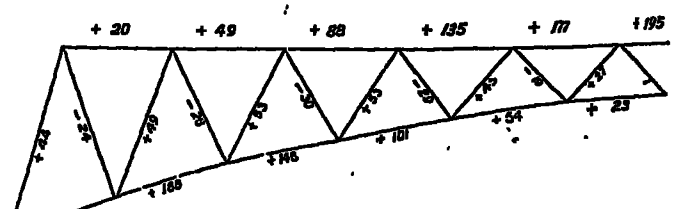


Fig. 80.

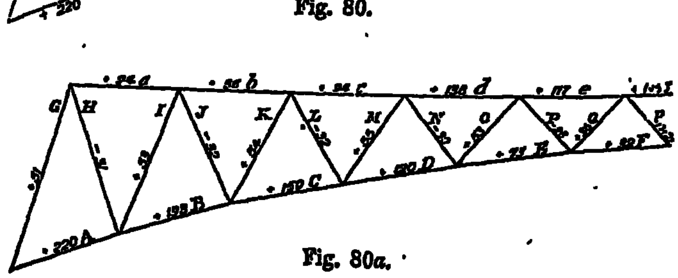


Fig. 80*a*.

Fig. 80 shows half the frame of a bridge for which the calculations have been made. The span is 120 feet, the rise 12 feet, and the truss 5 feet deep at the crown. The load assumed is 10 tons

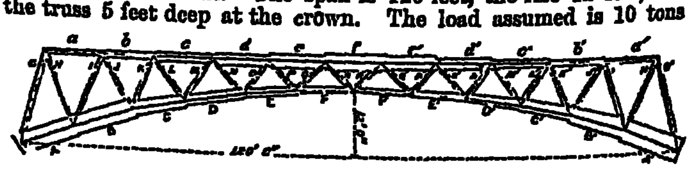


Fig. 81.

permanently on each top joint, and 10 tons of passing load. On fig. 80 are marked the stresses when the bridge is wholly covered with the passing load. On fig. 80*a* are marked the maximum stresses with any distribution of load. Figs. 81 and 82 show graphi-

cally the amount of metal required in this bridge and in a girder of the same span and 12 feet deep; the breadth given in the diagram to each member is proportional to the cross section required. The quantity of metal required for the girder exceeds that for the arch in the ratio of about 175 to 100: a similar calculation for a bowstring

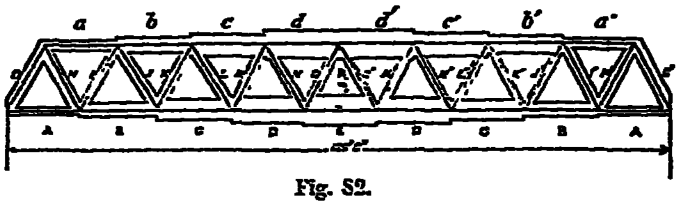


Fig. 82.

lattice girder 17 feet deep at the centre gives the ratio between the weights of metal required as 100 for the arch and 155 for the bowstring. Even these ratios understate the great advantage to be derived from the braced arch or suspension bridge for large spans, since they assume that the loads to be carried are the same, whereas the permanent load is in large spans much less for the lighter construction of bridge. The following table shows the probable weight in tons of several different types of trusses, assuming that the maximum intensity of stress on the metal in girders and arches is everywhere 4 tons per square inch, that the passing load to be carried is 1·4 tons per foot run, and that the practical weight is 25 per cent. in excess of the minimum possible weight if no metal were wasted, vide *Trans. R.S.S.A.*, vol. viii. p. 135. It must be remembered that the abutments for arches will in all cases be more expensive than those for girders; in small spans this expense will often outweigh the saving which could be effected in the superstructure by employing the arch.

TABLE XII.—*Weights of Trusses of different types.*

Span.	Weight of wrought iron Girder in tons.		Weight of wrought iron Bowstring, in tons.		Weight of wrought iron Suspension Bridge, and wrought iron or cast iron Arch, in tons.		Weight of wooden Arch, in tons.		Weight of Suspension Bridge, in tons. Strain 8 tons per square inch.	
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Feet.	Total.	Per ft. run.	Total.	Per foot run.	Total.	Per ft. run.	Total.	Per ft. run.	Total.	Per ft. run.
200	83	·415	70	·35	41	·205	57·1	·285	19	0·095
300	222	·74	180	·60	100	·33	142	·473	45	0·15
400	475	1·19	375	·94	194	·485	285	·712	83	0·207
500	940	1·88	700	1·4	330	·65	510	1·02	134	0·268
600	2,220	3·7	1260	2·1	530	·883	870	1·45	200	0·333
700	3,900	5·57	2290	3·27	790	1·13	1440	2·06	280	0·400
800	12,800	16·	4450	5·56	1180	1·475			384	0·48
1000					2490	2·49			655	0·655
1200					5600	4·67			1060	0·885
1400									1580	1·128
1600									2360	1·475
1800									3410	1·89
2000									4950	2·475

The framed arch is a very suitable form for wooden bridges. The ties are few and subject to insignificant strains. In designing a series of arches supported on piers care must be taken to provide for the thrust from loaded to unloaded arches across the pier at the springing.

§ 57. *Strength of Struts.*—When a strut or column is used as in framework to resist compression, it is usually so long in comparison with its cross section that it will bend and yield with a much less stress than would be required to crush the material. The strength of a strut of this kind can be approximately computed according to the following theory:—

Fig. 83.

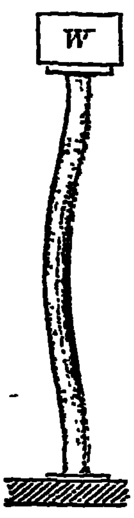


Fig. 84.

Let a strut with a cross section S be pinned or hinged at both ends, or let it have round ends, so that if it yields under compression it bends as in fig. 83. Let the cross section have two axes of symmetry, and let the section be such that the column will bend in the plane of one axis; let the depth of cross section measured in this direction be called d, and the breadth measured at right angles to the depth d be called b. Let the maximum or breaking load be called P, and the maximum deflection of the longitudinal axis of the strut from its unbent position be called v, this quantity being *analogous to the deflection in a beam.* The moment tending to produce flexure at the cross section where v is measured will be Pv. This moment must, as in the case of a girder, be equal to the moment of the elastic forces, which we already know to be—

$$u = \frac{2p_1 I}{d},$$

where p_1 and I have the same signification as for girders.

(I must be taken about the unstrained axis, or in other words about the axis running in the direction which has been called that of the breadth.) Hence we have—

$$Pv = \frac{2p_1 I}{d}, \text{ or } p_1 = \frac{Pvd}{2I};$$

but we also know that for beams of uniform cross section under similar internal stresses v is proportional to $\frac{l^2}{d}$; hence we have—

$$1. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad p_1 = a\frac{Pl^2}{I},$$

where a is a constant depending on the material only. Let $p_0 = \frac{P}{S}$ be the mean intensity of stress which would be produced if the load compressed all parts of the cross section equally, and let f_c as before be the ultimate strength of the material per unit of cross section, then, when the beam is on the point of yielding, we must have $f_c = p_0 + p_1$, or—

$$f_c = \frac{P}{S} + a\frac{Pl^2}{I},$$

and calling r the radius of gyration—

$$2. \quad . \quad . \quad . \quad . \quad f_c = \frac{P}{S}\left(1 + a\frac{l^2}{r^2}\right), \text{ or } P = \frac{f_c S}{1 + \frac{al^2}{r^2}},$$

from which f_c can be computed in terms of P and a, or P in terms of f_c and a.

The value of a does not change with a change in the design of the cross section; the values for cast iron, wrought iron, and wood determined by experiment are given in the following table, S being measured in square inches, P in lbs. The table also contains values of f_c.

TABLE XIII.—*Constants for the Strength of Struts and Pillars.*

	f_c.	a.
Cast-iron	80,000 lbs.	$\frac{1}{6400}$
Wrought iron	36,000 lbs.	$\frac{1}{9000}$
Dry timber	7,200 lbs.	$\frac{1}{750}$

When the direction of both ends of the column is fixed it must bend in the manner shown in fig. 84; if the curvature be uniform this would have the effect of reducing the deflection v to one-fourth of the amount caused by the same stresses when the ends are hinged, giving—

$$p_1 = \frac{aPl^2}{4I},$$

and

$$3. \quad . \quad . \quad . \quad f_c = \frac{P}{S}\left(1 + \frac{al^2}{4r^2}\right), \quad \text{or} \quad P = \frac{f_c S}{1 + \frac{al^2}{4r^2}}.$$

When one end is fixed in direction and the other hinged, the ultimate load which the strut can bear may be taken as a mean between the strength of two pillars of the same length and cross section, one having both ends fixed in direction and the other having both ends hinged; for similar cross sections r^2 is proportional to d^2, the square of the depth (measured in the direction of the shorter side or axis), thus the ratio $\frac{l^2}{r^2} \propto \frac{l^2}{d^2}$.

Let $n = \frac{d^2}{12r^2}$, and let $B = 3\frac{al^2}{d^2}$. Then from equation 2 we have for hinged ends—

$$4. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad P = \frac{fS}{1 + 4nB},$$

and from equation 3 for fixed ends—

$$5. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad P = \frac{fS}{1 + nB}.$$

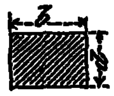
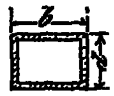
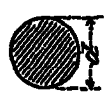
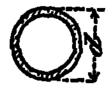
n has a constant value for all similar cross sections, and B a constant

value for any given materials and any constant ratio of l to v. Table XIV. gives the values of B for a series of these ratios, and Table XV. gives the values of n for the most usual cross sections.

TABLE XIV.—*Value of* B (*lbs. and square inches*), *Strength of Struts and Pillars.*

$\frac{l}{d}$	B for Cast Iron.	B for Wrought Iron.	B for Strong Dry Timber.
10	·187	0·033	·25
15	·42	·075	·9
20	·75	·133	1·6
25	1·16	·208	2·5
30	1·69	·3	3·6
35	2·3	·408	4·9
40	3·	·533	6·4
50	4·68	·833	10·

TABLE XV.—*Values of* n, *Strength of Struts and Pillars.*

	n	
Square of side d, or rectangle with smallest side d..............	1	
Hollow rectangle, thin sides	$\frac{1}{2}$	
Circle, diameter d	$1\frac{1}{3}$	
Thin ring, external diameter d	$\frac{2}{3}$	
Angle iron, smallest side d............	2	
Cruciform, smallest breadth $=d$......	2	

It is of great importance that the connections between the several struts and ties *forming* a frame should be so designed that the stresses produced may be *axial*. If this is not done the maximum intensity of stress on the strut or tie may greatly exceed those computed on the principles explained in the present paragraph (*vide* § 8).

Mr Unwin in his lectures gives the following empirical rules for the strength of wrought iron struts:—

$$P_1=\frac{fS}{1+\frac{l^2}{ch^2}} \text{ for fixed ends, ... } 6.$$

$$P_1=\frac{fS}{1+\frac{4l^2}{ch^2}} \text{ for round ends, ... } 7.$$

where different values are given to f and c according to the different cross sections of the struts.

Rectangular bars	$c=2500$	$f=17$ tons.
Cylindrical bars	$c=3500$	$f=17·5$ „
Angle, T, cross, and charcoal iron	$c=900$	$f=19$ „

The following are Mr Hodgkinson's formulæ for the strength of cast-iron cylindrical pillars, the length of which is not less than thirty times the diameter:—Let P be the load which will produce failure, d the external diameter in *inches*, L the length in *feet*, and A a constant multiplier; then for solid pillars with either round or flat ends—

$$8. \quad . \quad . \quad . \quad . \quad . \quad . \quad P=Ad^{3·6}\div L^{1·7}.$$

The value of A for rounded ends is 14·9 tons, and for flat ends 44·16 tons. Similarly for hollow pillars of internal diameter $d_{\prime}$ we have

$$9. \quad . \quad . \quad . \quad . \quad . \quad . \quad P=A(d^{3·6}-d_{\prime}^{3·6})\div L^{1·7},$$

where for rounded ends A is taken as 13 tons, and for flat ends 44·3 tons.

When the length is less than thirty times the diameter, let P be the ultimate load calculated by equations 8 and 9, and let $P_{\prime}$ be the load which would crush a short block of the same sectional area S; *i.e.*, let $P_{\prime}=49S$; let $P_{\prime\prime}$ be the actual ultimate strength, then, according to Professor Hodgkinson's experiments,

$$10. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad P_{\prime\prime}=\frac{4PP_{\prime}}{4P+3P_{\prime}}.$$

For rectangular struts of oak and pine, the smallest side being denoted as before by $d_{\prime\prime}$ Hodgkinson gives the formula—

$$11. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad P=A\frac{d^2}{l^2}S,$$

where A$=$3,000,000 lbs. The same unit must be employed for d and l, and S must be expressed in square inches. This formula can only give a rough approximation to the truth. In short beams the formula in § 5 would give a smaller strength than equation 11. This smaller value is, then, the true measure of the strength.

VI. COMPOUND STRUCTURES.

§ 58. Many bridges have been built with superstructures such that the stresses on the several parts or members cannot be computed by the rules hitherto given. These superstructures are generally constructed by superposing two or more types so as to form a compound structure capable of acting at once say as an arch and as a girder. These bridges may be called compound bridges. The designs are usually unworthy of imitation. Mr Robert Stevenson's original design for the Britannia Bridge, in which the great girder would have been partly supported by chains, is an example of this type of structure in which the two parts are clearly visible. Many wooden American bridges are trusses which almost defy analysis, the designs being, however, obviously suggested by an attempt to combine at least two of the three main types of bridges. No advantage whatever is gained by a combination of this kind; on the contrary great disadvantage is almost sure to follow its adoption, namely, that it will be impossible that each part of the structure should, under all circumstances, carry that portion of the load which the designer entrusted to it. For suppose a bridge constructed partly as a girder and partly as a suspension bridge, the girder being very stiff and deep and the chain perfectly flexible with considerable dip. Let the chain and girder be each fit to carry half the passing load. It is perfectly conceivable that the deflections of the two should be so different that the girder would, under the actual load, break before the chain was sensibly strained, or the difference in the relative dip of the chain and depth of the girder might be such as to cause the former to give way first. Even if the two were so designed that at a given temperature each should take the designed share of the load, a change of temperature would entirely alter the proportion borne by the two parts of the structure. A few forms are free from this defect, and these will now be described.

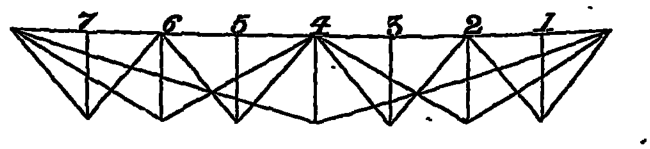


Fig. 85.

§ 59. *Fink Truss.*—This truss (fig. 85) has been much employed in America. The upright struts, numbered 1 to 7, divide the span into eight equal parts. If a weight w rests on the top of each strut the whole truss may be looked upon as made up of seven distinct and independent trusses superposed on one another; strut 4 is used seven times, and is compressed with a total force of $4w$. Struts 2 and 6 are used three times, and each compressed with a total force of $2w$. Struts 1, 3, 5, and 7 are used once, and each compressed with a force w. The stresses on the inclined ties are at once got from the compression of the strut by the resolution of forces; and the stress on the upper member or boom is the sum of all the pulls on the ties resolved horizontally;

the boom is uniformly strained over its whole length. This truss would not be so light as a Warren girder if both were made of the same depth, and if the end struts in the Warren girder did not require to be much stiffened in consequence of their great length. The Fink truss is, however, generally made in practice more cheaply than the Warren girder, because the depth of a girder practically depends on the greatest length of strut which is admissible, and for equal lengths of strut the Fink truss gives a deeper beam than the Warren girder.

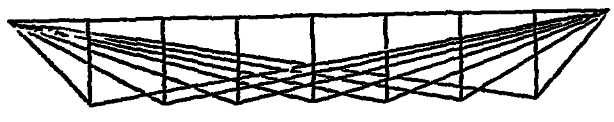


Fig. 86.

§ 60. *Bollman Truss* (fig. 86).—This truss is the result of superposing seven simple frames consisting of a top member, a strut, and two ties. The stresses are easily computed. It is one form of the old false suspension bridge already alluded to (§ 34), with the difference that the top member replaces the horizontal resistance at the points of support. The defect of this truss is that two ties supporting any strut except the central one are of unequal length; expansion or extension, consequently, affects these unequally. It is inferior to the Fink truss.

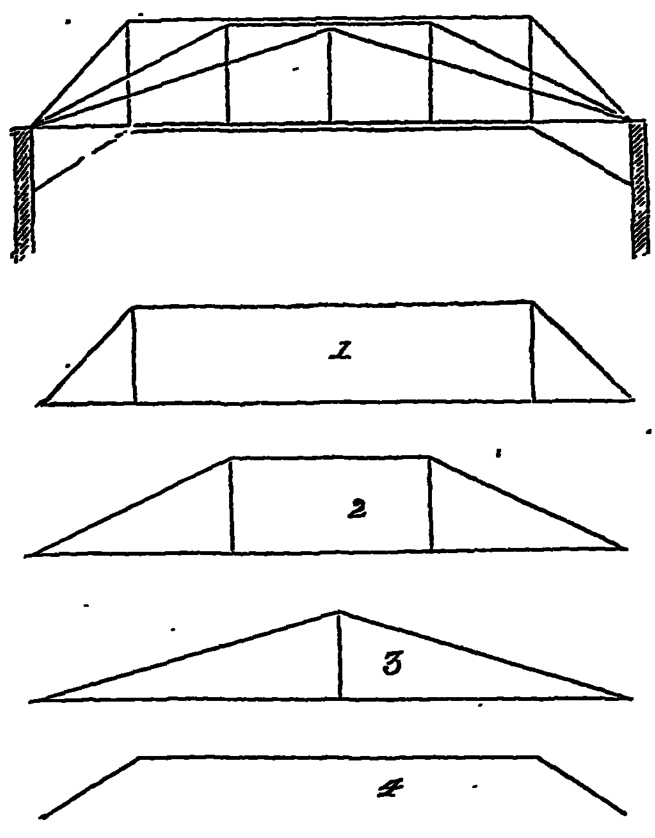


Fig. 87.

§ 61. *Schaffhausen Truss.*—The famous wooden bridge of Schaffhausen (fig. 87, see also § 76) is in its main parts a compound bridge, composed by superposing a series of simple frames of the type shown in 1, 2, 3, and 4. Nos. 1 and 2 are imperfect frames, *i.e.*, if the joints were flexible they would collapse in consequence of the want of the diagonals across the centre parallelogram. The stiffness of the joints supplies this want.

§ 62. *Dredge's Suspension Bridge.*—This bridge differs from the usual suspension bridge in having the suspending rods inclined, and in the use of a lower member, which may be a compression member transmitting a thrust to the piers, as in 88*a*, or a tension member, as in 88*b*, with a

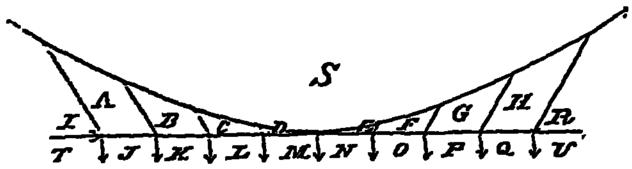


Fig. 88*a*.

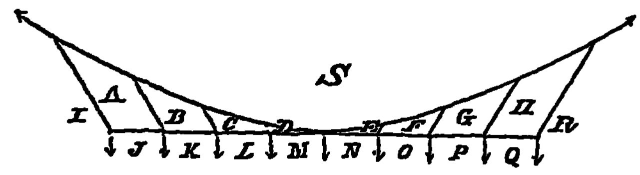


Fig. 88*b*.

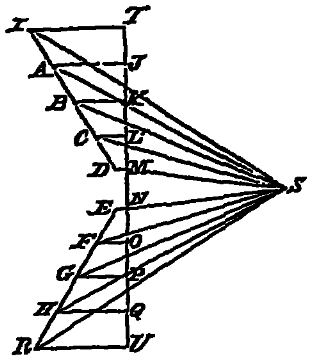


Fig. 88*c*.

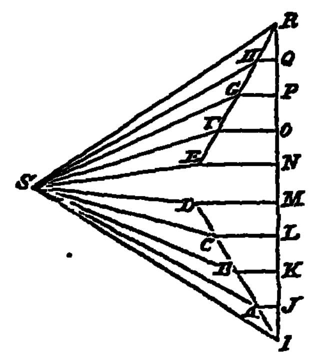


Fig. 88*d*.

maximum tension at the centre. Fig. 88*c* and fig. 88*d* show the reciprocal figures corresponding to those two cases. This bridge is somewhat stiffer than the ordinary suspension bridge, but is far inferior to the complete framed bridge.

§ 63. *Arch or Suspension Bridge, hinged at Abutments and Centre.*—Figs. 89 and 90 show two designs of considerable merit, consisting of two frames (the shape of which might vary considerably) hinged together at A, and

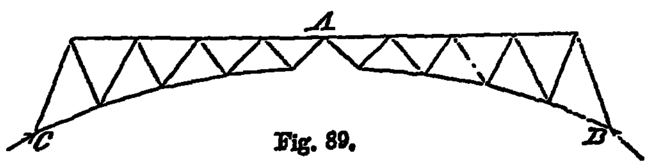


Fig. 89.

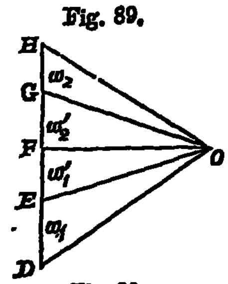


Fig. 89*a*.

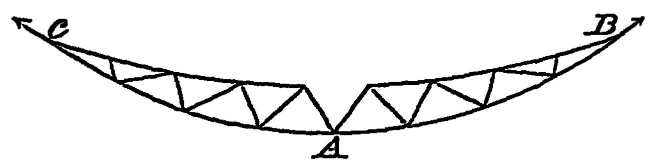


Fig. 90.

supported on hinges at B and C. The direction of the sustaining forces at A and B is to be determined as for a simple pair of beams hinged at A, B, and C. Find w_1 and w_1', the proportions of the load on AC borne by C and A re-

spectively; and w_2 and w_2' the proportions of the load on AB borne by B and A respectively. Then draw the line of loads DEFGH as sketched (fig. 89*a*). From E and G draw lines parallel to AC and AB respectively, meeting in O. Join OD and OH. OD and OH represent in magnitude and direction the thrust on C and on B. OF is the stress on the pin at A. These thrusts being known, the stress on each member of each frame can be easily computed by a reciprocal figure or otherwise. This form is only inferior to the true framed arch or suspension bridge inasmuch as it is incapable of balancing the thrust due to the passing load on neighbouring spans. It is superior to the framed arch and suspension bridge inasmuch as it cannot be strained by any change of temperature.

VII SUBSTRUCTURE.

§ 64. *Preliminary.*—The substructure of a bridge comprises the piers, abutments, and foundations. These portions of the bridge usually consist of masonry in some form, including under that general head stone masonry, brickwork, and concrete. Occasionally metal work or woodwork is used for intermediate piers.

When girders form the superstructure, the resultant pressure on the piers or abutments is vertical, and the dimensions of these are simply regulated by the sufficiency to bear this vertical load.

When arches form the superstructure, the abutment must be so designed as to transmit the resultant thrust to the foundation in a safe direction, and so distributed that no part may be unduly compressed. The intermediate piers should also have considerable stability, so as to counterbalance the thrust arising when one arch is loaded while the other is free from load.

For suspension bridges the abutment forming the anchorage must be so designed as to be thoroughly stable under the greatest pull which the chains can exert. The piers require to be carried above the platform, and their design must be modified according to the type of suspension bridge adopted. When the resultant pressure is not vertical on the piers these must be constructed to meet the inclined pressure. In any stiffened suspension bridge the action of the pier will be analogous to that of a pier between two arches.

§ 65. *Stability.*—When the magnitude and direction of the thrust borne by a pier or abutment at the springing are known, the stability of any series of masonry blocks forming the pier or abutment may be studied by drawing lines showing the direction and magnitude of the resultant force on each joint. This may be done as for the voussoirs of an arch. The thrust on the upper block may be compounded with the weight of that block, the resultant compounded with the weight of the next, and so forth, until the direction and magnitude of the thrust on the rock or earth foundation is determined.

A better method of making the drawing is shown in fig. 91; find the centre of gravity $C_{\prime}$ of block 1, the centre of gravity $C_{\prime\prime}$ of blocks 1 and 2 treated as a single mass, similarly $C_{\prime\prime\prime}$ for blocks 1, 2, and 3 Let AT be the direction of the thrust on the top block, and $C_{\prime}B_{\prime}$ a vertical line though $C_{\prime}$ cutting AT in $B_{\prime}$; let $B_{\prime}D_{\prime}$ be the direction of the resultant of t, the thrust acting in the line AT, and $w_{\prime}$ the weight of the first block acting in the line $C_{\prime}B_{\prime}$; and let $D_{\prime}$ be the point where the direction of this resultant cuts the first joint; similarly let $B_{\prime\prime}D_{\prime\prime}$ be the direction of the resultant of t and the weight $w_{\prime}+w_{\prime\prime}$ of the first two blocks; $B_{\prime\prime\prime}D_{\prime\prime\prime}$ the direction of the resultant of t compounded with the weight $w_{\prime}+w_{\prime\prime}+w_{\prime\prime\prime}$ of the three first blocks, &c., &c. This method of proceeding gives the direction and magnitude of each force and centre of pressure D independently of the values obtained for the preceding joints. For stability the line BD must not make a greater angle with the normal to the joint than the angle of repose; and the point D must nowhere fall beyond the edge of the joint; for strength and safety the point D might be required to fall within the middle two-thirds of the joint, or within the middle three-quarters. The theory by which the joints furthest from the centre of pressure would open when the centre of pressure leaves the

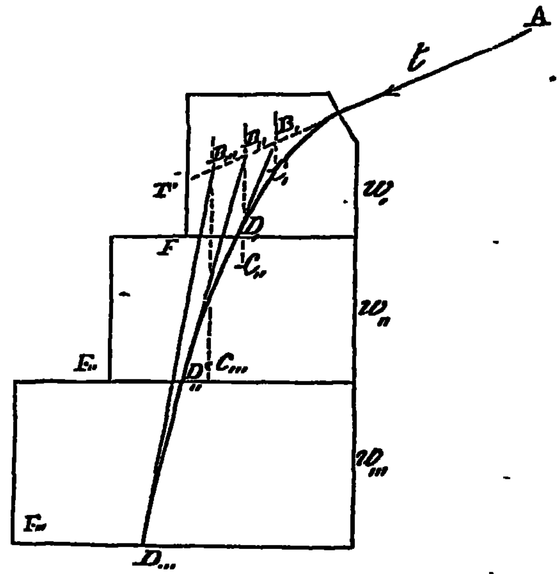


Fig. 91.

middle third cannot apply to such a structure as a masonry abutment, all parts of which are bonded together. Professor G. Fuller calculates the thickness of abutments by the following empirical rule, deduced from many practical examples:—Let c = half the span in feet; d = versed sine in feet; t = thickness of abutment at springing; then, for flat arches, in which the span does not exceed 150 feet, and the ratio of the rise to the span is not less than 116, we may write $t = \cdot17\left(\frac{c^2}{d} + d\right)$. From the springing to the base the abutment may have a batter of 1 in 4. This gives an abutment the cubic capacity of which will be sufficient, but it may with advantage be divided into abutment proper and counterforts; in semicircular arches t should be taken as the thickness of the abutment at a height above the springing equal to two-thirds of the radius. The maximum intensity of stress on the stone at the edge F might be approximately found by the theory explained in § 8. This theory finds a useful application in calculating the maximum intensity of stress which a given foundation might produce on the earth

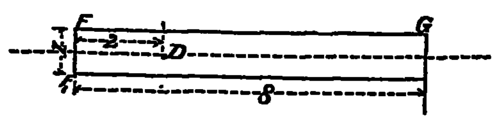


Fig. 92.

or rock supporting it. Thus, let the section of the foundation under consideration be 1 foot in breadth, 8 feet in length from F to G, as shown in plan, fig. 92; let the centre of pressure D be 2 feet from FF, and let the total resultant thrust be about 16·5 tons, inclined so that the horizontal component is 4 tons and the vertical component 16 tons, then the mean vertical intensity of pressure per square foot is $\frac{16}{8} = 2$, and the maximum intensity along the line FF, is by equation 2, § 8—

$$2\left\{1+(4\times2\times8)\frac{12}{512}\right\} = 5,$$

this maximum intensity being $2\frac{1}{2}$ times as great as the mean intensity. Obviously, although for the sake of appearance the courses of masonry in the abutment of an arch may be left horizontal in the face, the stability is increased by inclining them at a proper angle, so that they lie normal to the thrust.

The stability of abutments may be tested by taking moments round points in the joints selected as the points beyond which the thrust must not come. The same methods apply to the ancherages of suspension bridges, and to intermediate piers, which are intended to take a given horizontal thrust. When metal or wooden piers are adopted their weight will generally be insignificant, and such as may be neglected in calculating their stability. Metal-work piers or wooden piers usually consist of wrought or cast-iron frame work, and the stress on each part of the frame, as well as the resultant stress on the foundations where each upright member reaches it, is

easily calculated by the method of reciprocal figures or otherwise.

Occasionally metal piers are continuous metal structures, such as cast-iron cylinders. The maximum intensity of stress can then be calculated by resolving the thrust on the upper part of the pier into a horizontal and a vertical component, calculating the bending moment produced on each horizontal cross section by the horizontal component, and adding the intensity of stress caused by this bending moment to the mean intensity caused by direct compression. The manner in which any metal-work pier is held by its foundation against a bending moment will require special consideration; the resultant pressure should always fall well within the base.

§ 66. *Practice.*—In the design of the usual masonry bridge the thickness of the pier is generally determined by practical considerations. In small arches the pier is made thick enough to allow the two rings of the two abutting arches to spring from the pier without interfering with one another, a clearance of about half a brick being often allowed between the two rings. In larger arches the piers will generally be found to vary in thickness from $\frac{1}{8}$th to $\frac{1}{10}$th of the span, with a slight batter (*i.e.*, with walls spreading outward towards the base). In very old bridges piers are sometimes found equal in width to the opening of the arch. In large bridges, or with very high piers, care must be taken that the pressure per square foot on the masonry or foundation does not exceed a safe value. The brickwork in the piers of Charing Cross bridge is subject to a compression of 9 tons per square foot; four or five tons is a much more usual load. Eight tons per square foot may be considered a maximum for rubble stone-work, and perhaps 20 tons for the best dressed ashlar. Strong concrete may be trusted with 3 tons; firm rock foundations with 9 tons, soft sandstone with 2 tons, and firm earth with from 1 to $1\frac{1}{2}$ tons. The depth of the first course below the surface (on dry land) should not be less than 3 feet in sand and 4 feet in clay.

When framework, either of wood or iron, is used as a pier, care must be taken by cross-bracing to provide against the effect of wind and vibration.

§ 67. *Site.*—The site proposed for a pier must be carefully examined by borings; the ground should be uniform, for if a pier rests partly on one formation and partly on another, unequal settlement will certainly occur, even if the weaker formation be such as would have been amply strong enough to bear the pressure had the pier been wholly founded upon it. Solid rock may be considered the best foundation, but where rock is broken up by cracks or other inequalities it is inferior to such formations as uniform gravel, chalk, and some kinds of sand and clay. These foundations may be described as incompressible. The worst foundations are afforded by those formations which can be compressed or squeezed out sideways by the imposition of weight. Muddy earth, certain clays, and certain sands are of this nature. Alternate beds of stone and slippery clay are very treacherous. The foundation should be dressed level so that the masonry may everywhere start from the same height, and therefore settle equally. Unavoidable inequalities are better filled up by concrete than by masonry.

For foundations in water it is very important that the ground should not be such as can be scoured away by the current or wash of the water; many bridges have failed by the undermining of the piers due to this cause. Special precautions, to be presently described, must be taken against the effects of the scour if the soil itself is not of a sufficiently resisting nature. The piers must be so placed and formed that the obstruction to the flow of water may be as small as possible and the effect which the piers will have in altering the level of the stream above and below the bridge must be considered. Data as to the maximum flood waters to be provided for must be examined; and provision must in some climates be made against ice by suitable cut-waters or fenders, an example of which is given in fig. 93, showing a pier of the Victoria Bridge, Montreal.

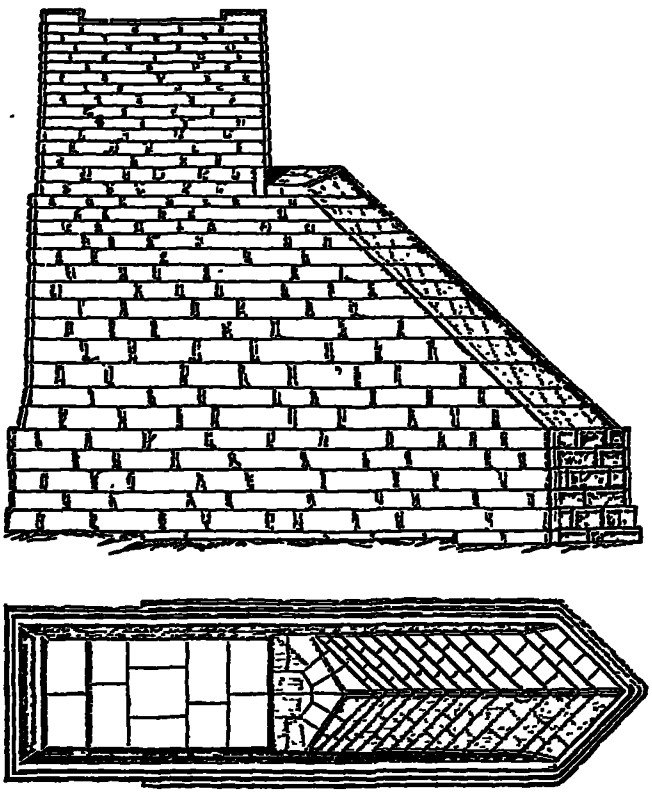


FIG. 93.—Side Elevation and Plan of Pier.

§ 68. *Mode of Founding in Water.*—The chief difficulty met with by an engineer about to erect a large bridge over a deep stream is to secure a sound foundation for the piers. The following are some of the principal methods of building piers in or under water:—

Cofferdams.—Cofferdams are embankments or dams which surround the site so as to exclude the water from it. They are formed in general by driving two rows of piles round the site so as to enclose between them a water-tight wall of clay puddle; in depths of less than 3 or 4 feet, where there is little current, a simple clay dam may be used. In greater depths, the timber walls consist of guide piles at intervals, with some form of sheet piling between them; in extreme depths the timber walls may be composed of stout piles driven in side by side all round. The dam must be sufficiently strong to bear the pressure of the water against the outside when the space enclosed has been pumped dry. Rankine states that the common rule for the thickness of a cofferdam is to make it equal to the height above ground if the height does not exceed 10 feet, and for greater heights, to add to 10 feet one-third of the excess of the height above 10 feet. The "Cours de Ponts" at the school of the Ponts et Chaussées, states that a cofferdam need never be made of greater thickness than from 4 to 6 feet, as the interior can always be sufficiently stayed inside. This method of founding is now seldom practised; it is costly and causes great obstruction in the stream.

Caissons.—Some foundations have been constructed as follows:—A level or nearly level bed was prepared in the stream by digging or by driving piles and sawing off the heads at a uniform depth; a huge timber box, called a caisson, was then filled with masonry, and sunk on the foundation thus roughly prepared. This method is now abandoned. It was peculiarly liable to danger from the scour of the stream. The name caisson is also sometimes

applied to a mere frame with wooden walls which is floated to the site of the pier, and there sunk so as to form an enclosure, inside which concrete can be shot and can set undisturbed by the wash of the water.

Concrete in a shell is a name which might be applied to all the methods of founding a pier which depend on the very valuable property which strong hydraulic concrete possesses of setting into a solid mass under water. The required space is enclosed by a wooden or iron shell; the soil inside the shell is removed by dredging, or some form of mechanical excavator, until the formation is reached which is to support the pier; the concrete is then shot into the enclosed space from a height of about 10 feet, and rammed down in layers about 1 foot thick; it soon consolidates into a permanent artificial stone. The shell,

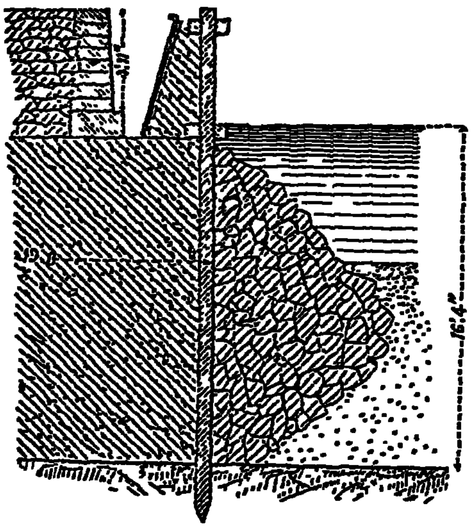


Fig. 94.

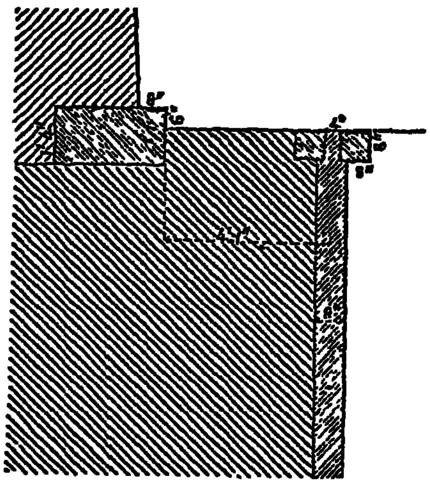


Fig. 94a.

unless of small size or very strong form, requires to be braced to meet the outward pressure of the concrete. The

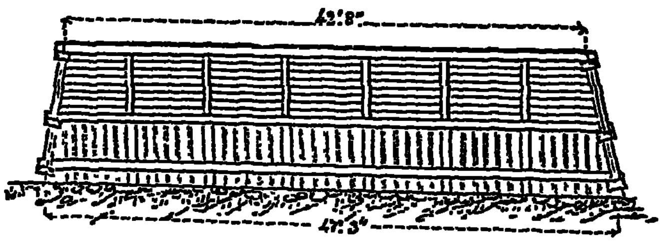


FIG. 95.—Caisson used for a Bridge over the Cher.

concrete used for this purpose is often called béton, to distinguish it from inferior mixtures used for foundations on land. It may consist of angular stones $1\frac{1}{2}$ to 2 inches diameter, mixed with strong hydraulic mortar in the proportion of from one to two volumes of stones with one of mortar; the final volume may be from $\frac{4}{5}$ to $\frac{5}{6}$ of the unmixed materials. Béton used at Biarritz consisted of one part Portland cement, two parts sand, and three parts broken stones; at Genoa one part rich lime, two parts pozzuolana, three parts broken stones.

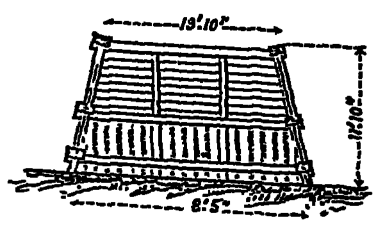


Fig. 95a.

Fig. 94 shows a section of foundations constructed by filling a casing of piles with concrete in this manner; the shell is protected against scour by large stones heaped round the outside, part of the loose earth having been removed by digging. Fig. 94a shows the manner in which the concrete foundation was finished after removal of the temporary external wall shown in fig. 94.

Figs. 95 and 95a show a longitudinal elevation and cross section of a wooden shell, or caisson without a bottom, intended to be sunk to receive concrete. Cast-iron guide piles and sheet piling are also used for this class of foundation.

Cast-iron tubular shells are now frequently employed; the tube forms a large hollow pile, which may descend into the ground by its own weight, or by added weight while the soil inside is removed by some kind of dredge or excavator, such as Milroy's, worked from the surface. When the lower edge of the shell has penetrated the formation to be used as a foundation, the water inside may be pumped out if the soil forms a water-tight joint, or the shell may simply be filled up with concrete shot into the enclosed water. The piers of Charing Cross bridge (fig. 96) were constructed in this way; the excavation inside the tube (14 feet diameter), was carried on by divers with helmets until the shell had entered a few feet into the London clay. The water was then pumped out and excavation continued; the cylinders were loaded with about 150 tons to sink them to the final depth.

Compressed air is now very generally employed inside a metal shell for those foundations in which the excavation requires the presence of workmen at the bottom of the shell. The metal shell is open at the bottom, but air-tight and water-tight at all other points; there is a chamber called an *air-lock* at the upper part. This "air-lock" serves for the exit and entrance of the workmen and materials; the air in this comparatively small space is lowered to the pressure of the atmosphere before the chamber is opened for the passage of men or materials to the open air; the air is again compressed in the air-lock before it is opened for communication with the body of the shell in which the air is permanently kept at such a pressure as will keep the water down to the required level. The shell thus acts as a diving bell acts. It is found that men cannot in general be safely employed under a greater pressure than two atmospheres above the ordinary atmospheric pressure, corresponding to a depth in water of about 65 feet. The centre pier of Saltash Bridge was, however, in 1855 by this plan carried down to a depth of 87 feet 6 inches below high water. Recently the foundations of St Louis bridge over the Mississippi have by the same method been established at a depth of

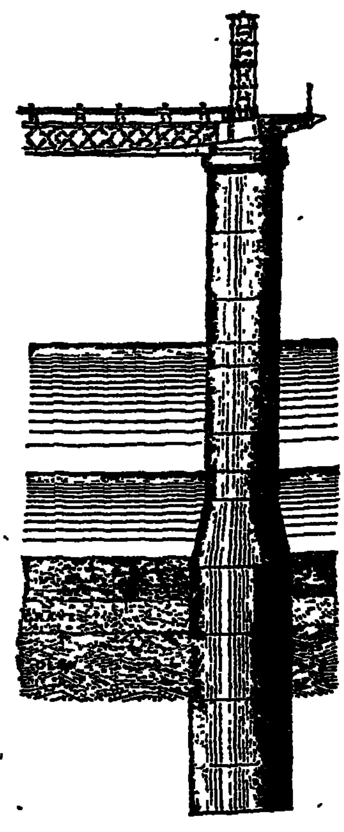


FIG. 96.—Cylinder, Charing Cross Bridge.

110 feet from the surface of the water. Figs. 97 and 97 A show the pier of the bridge of Argenteuil. Excavation was carried on in the lower chamber, the roof of which was very strongly built of metal, and served as the foundation for masonry and concrete built up round an inner tube, serving as a passage for men and materials to the upper chamber and "air lock." This lock is formed of two concentric cylinders of 3·9 feet and 10·8 feet diameter respectively (fig. 97*a*). The annular space was divided by two vertical partitions; the doors of communication (which were air-tight) were 1·8 feet wide and 2·14 feet high. A small engine worked the hoist by a stuffing-box passing through the shell. A safety-valve is of course required. The upward pressure of the air requires to be counterbalanced by weights. In the Argenteuil bridge this necessary weight was afforded by the masonry built in the tube as the tube sank. This plan seems preferable to the method of loading the shell externally with pig or railway iron. Frequently, owing to the tenacious nature of the soil, the water cannot be driven out below the tube, and in that case a syphon must be provided passing out at the top. The Argenteuil tube was sunk at a mean rate of about 18 inches per diem. This method is not confined to cylindrical tubes. Fig. 98 shows the method employed in building the piers of the bridge at Kehl over the Rhine. In this case four rectangular working chambers were sunk side by side and bolted together; each chamber communicated with the surface by two air-passages, and one central elliptical passage which remained full of water. This central passage served for the exit of the excavated material. A mass of concrete was built resting on the working chambers, and contained by wooden framework. The concrete was added at the top above water as the foundations gradually sank. At Mantes and Chalons wrought iron caissons, shaped like the usual masonry piers, have been sunk by analogous methods.

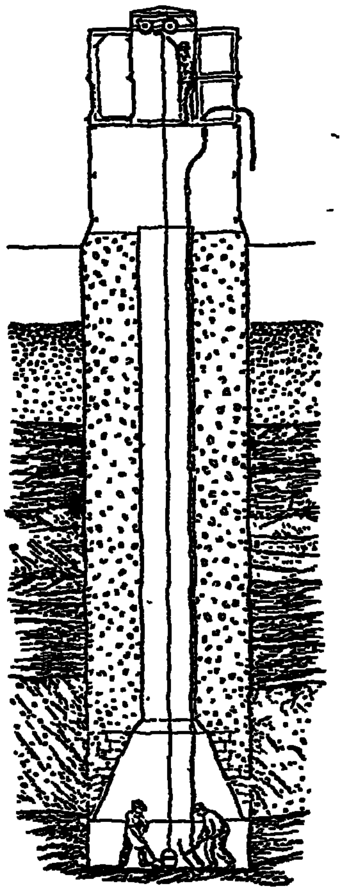


FIG. 97.—Foundations, Bridge of Argenteuil.

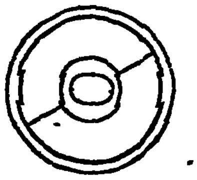


Fig. 97*a*.

The method of sinking cylinders by compressed air was invented by Mr Triger in 1841, and was first used on a large scale by Mr Hughes at Rochester. The tubes at this bridge were designed to be sunk by having the air *exhausted* inside the tube, a system invented by Dr Potts.

§ 69. *Piles* are used either to enclose a space or to bear part of the weight of a structure; for the former purpose a wooden pile may be a round or square pointed piece of timber, 6 or 9 inches in diameter and 8 or 12 feet long. Bearing piles may be of any dimensions which can practically be procured, and several lengths of timber are often jointed so as to form one long strut. The point is armed with metal, and the head protected by a metal ring, which prevents it from spreading when struck by the rammer which drives the pile. Bearing piles are usually placed at a distance from centre to centre not less than 2 feet 6

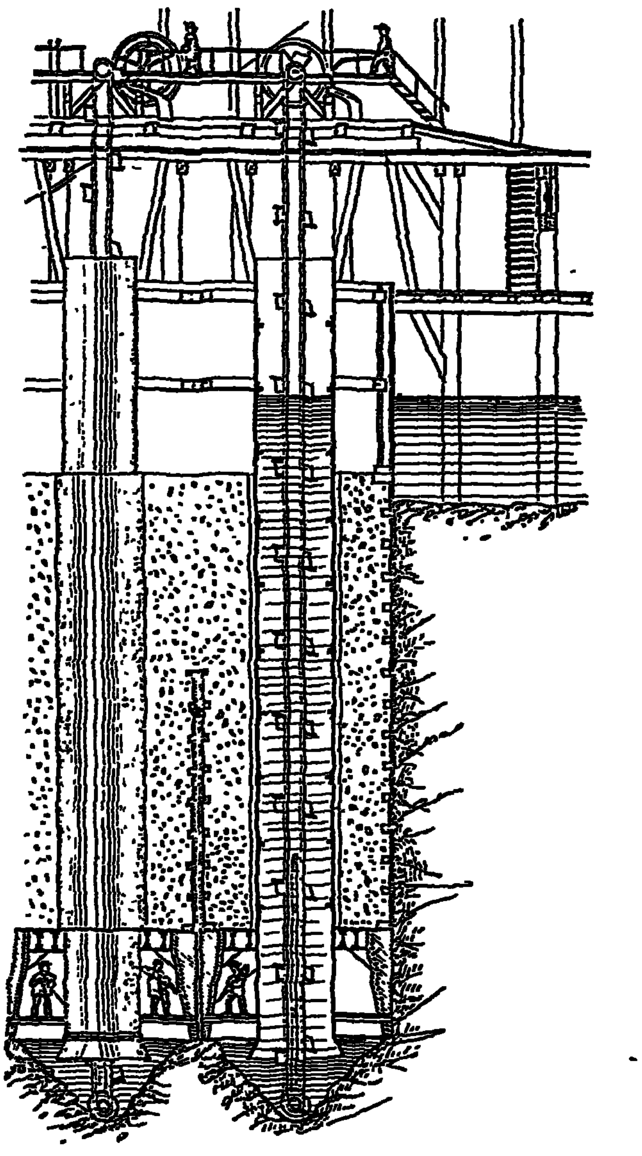


FIG. 98.—Foundations, Bridge of Kehl on the Rhine.

inches or more than 4 feet; 3 feet is a common distance. The diameter of bearing piles varies from 9 inches to 20 inches; a pile may be considered to be driven home when, with thirty blows of a ram weighing 800 lb and falling 5 feet, it does not move $\frac{1}{5}$th of an inch (Rankine). A French rule gives as a limit $\frac{1}{5}$ inch motion with twenty-five blows from a ram weighing 6 cwt. and falling 4 feet 3 inches. A pile which does not move more than this will bear from 600 to 1000 lb per square inch. This would give a load of 50 tons for a 13-inch pile; if, as is more usual, the load be only 8 or 10 tons for a 13-inch pile, the ultimate rate of descent may be three, four, or five times as much as the above.

Piles are used as foundations in those grounds which are compressible, or which would be squeezed out from beneath masonry under the weight to be borne. The wooden bearing piles are usually sawn off so that all the heads may be level, and a wooden grating or platform rests on the heads, over which the concrete or masonry pier may be built; in other cases the piles come up for some distance into the concrete. An external row of wooden piles is not unfrequently employed as a precaution against scour, but these should always be further protected by a stone bank, which will continue to protect the pier if the piles decay. A

more thorough protection against scour is provided by covering the centre bed of the river with a concrete or stone

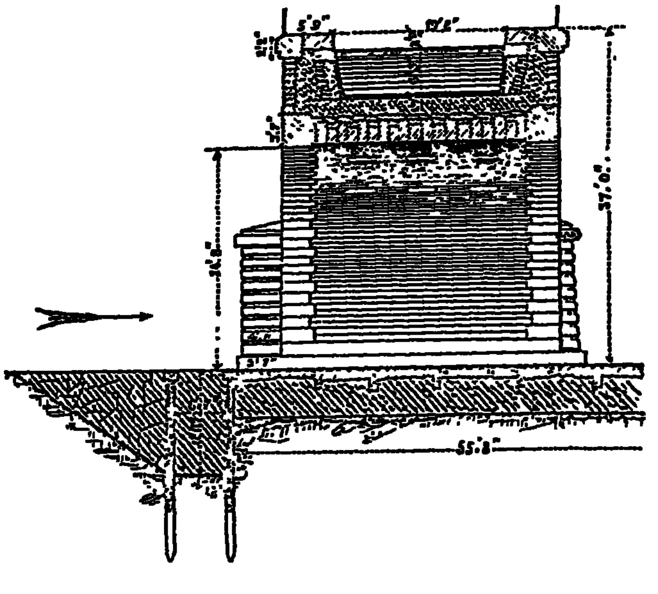


FIG. 99.—Aqueduct of Guétin over the Allier.

floor, as in fig. 99, representing a pier of the aqueduct crossing the Allier at Guétin.

Cast-iron guide piles (usually hollow tubes) are used for the same purpose as wooden guide piles. They may be cast with grooves down one edge in which sheet piling is held. Cast-iron and wooden piles are frequently used as part of the open-work metal or wooden framing of piers. In situations where these piles are not liable to injury by ice, floating timber, or barges, this construction is very economical. Fig. 4, Plate XIX. shows the Crumlin viaduct, with piers of this character, the construction of which will be more fully described in paragraph 79

Fig. 100 shows the Portage bridge (234 feet high) spanning the Genesee River, in the State of New York. The piers are large wooden frames.

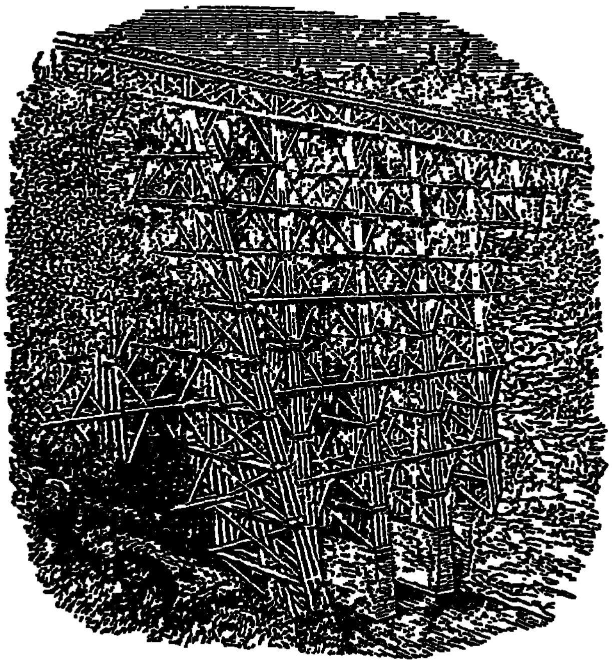


FIG. 100.—Portage Bridge.

§ 70. *Screw piles* are cast-iron piles which are screwed into the soil instead of being driven in. At their end is fixed a blade of cast-iron from two to eight times the diameter of the shaft of the pile; the pitch of the screw varies from one-half to one-fourth of the external diameter of the blade. The pile is turned by levers radiating from its head. In one example of their use (Rankine) the pile was screwed in by four levers, each 40 feet in length, with eight bullocks harnessed to it. The screws were 4 feet 6 inches in diameter, and the working load borne by them was 100 ℔ per square inch. The piles were screwed from 20 to 45 feet deep in earth.

Disc piles have been used in sand. These piles had a flat flange at the bottom, and water was pumped in at the top of the pile, which was weighted to prevent it from rising. Sand was thus blown or pumped from below the piles, which were thus easily lowered in ground which had baffled all attempts to drive in piles by blows. In ground which is of the nature of quicksand, piles will often slowly rise to their original position after each blow.

§ 71. *Wells.*—In some soils foundations may be obtained by the device of building a masonry casing like that of a well and excavating the soil inside; the casing gradually sinks and the masonry is continued at the surface. This method is applicable in running sands. The interior of the well is generally filled up with concrete or brick when the required depth has been reached, but in some cases a mere floor or inverted arch would be preferable.

VIII. EXAMPLES.

§ 72. The task of selecting a limited number of bridges

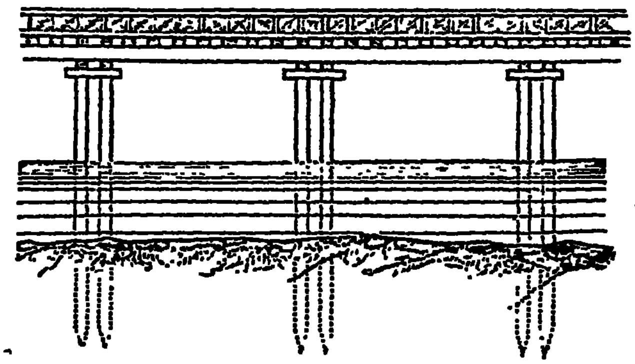


FIG. 101.—Pons Sublicius.

which shall represent the gradual progress in the art of construction and illustrate our present practice is one of much difficulty. Many very admirable and interesting structures must necessarily be passed over in silence, and space will not admit of full details being given even of those bridges which are noticed.

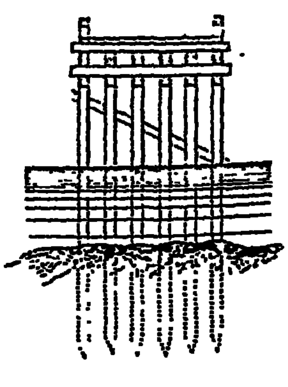
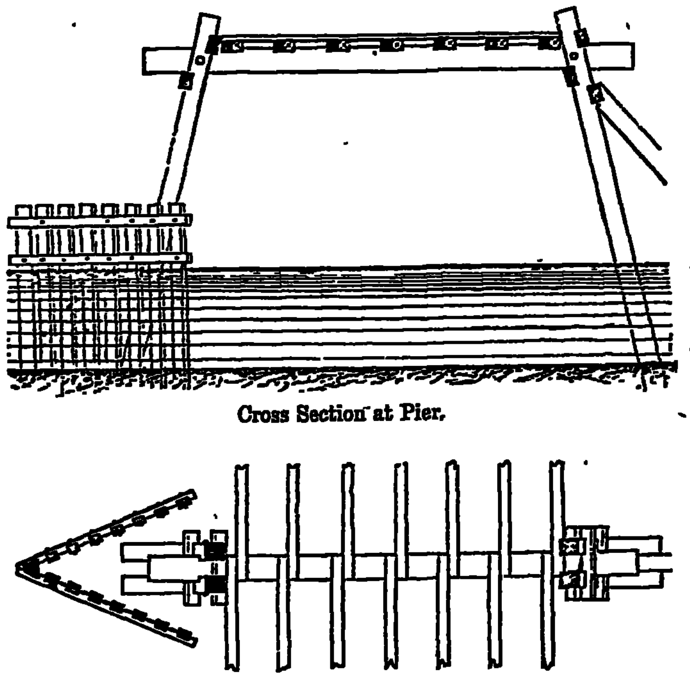


Fig. 101a.

§ 73. *Bridges built before the year* 1000 A.D.—Herodotus mentions a bridge erected by Nitocris over the Euphrates at Babylon. It appears to have consisted of stone piers connected by planking, which was removed at night. The river was diverted to allow the piers to be built. Diodorus Siculus ascribes the work to Semiramis.

The first bridge constructed at Rome was called the *Pons Sublicius*, or wooden bridge (*sublica* meaning a stake or Sublician
pile). It is said to have been built by Ancus Martius, and Bridge.
rebuilt by the chief priests, who from this circumstance were called "Pontifices." Fig. 101 shows the design of this bridge as restored by Colonel Emy (*Traité de l'art*

de la charpenterie) from the descriptions given in the historians. This was the bridge defended by Horatius Cocles.



Cross Section at Pier.

Plan at Pier.

FIG. 102.—Bridge thrown across the Rhine by Julius Cæsar.

Fig. 102, also taken from the work of Colonel Emy, is intended to represent the design of the bridge thrown across the Rhine in ten days by Julius Cæsar (*De Bell. Gall.* iv. 17).

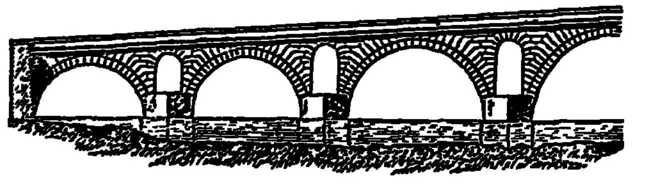


FIG. 103.—Pons Milvius.

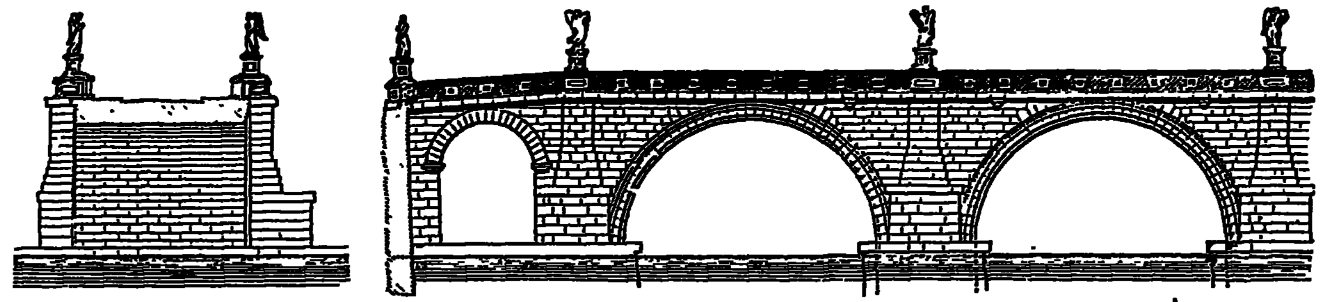
The *Pons Milvius* (fig. 103), now Ponte Molle, was built a mile and a half from Rome by the Censor Ælius Scaurus, about 100 B.C. Some part of the first bridge is supposed to remain, although it has been altered from time to time. The arches vary in their opening from 51 feet to 79 feet 9 inches; the waterway between the piers is 413 feet 3 inches; the breadth of the bridge, 28 feet 9 inches; these dimensions are given on the authority of Cresy (*Encyclopædia of Civil Engineering*). The following bridges also crossed the Tiber at Rome:—The *Pons Palatinus*, which stood on the site of the present Ponte Rotto; the *Pons Fabricius* and *Pons Cestius*, which still remain; the *Pons Janiculanus*, which occupied the site of the modern Ponte Sisto; the *Pons Vaticanus*, which has disappeared; and the *Pons Ælius*, built by Hadrian (13 A.D.), now the bridge of St Angelo. This bridge (fig. 104) was repaired by Popes Nicholas III. and Clement IX. The largest arch has a span of 62 feet 4 inches, and the width of the bridge is 50 feet 9 inches.

Pons Milvius

Other Roman bridges.

The bridge erected by Trajan (104 A.D.) across the Danube, just below the rapids of the Iron Gate, has been the subject of much controversy. The drawing (fig. 105) was originally taken from a bas-relief on the Trajan column at Rome. A description of the bridge is given by the ancient historian Dion Cassius, who states that the bridge had twenty piers of hewn stone, 150 feet high and 60 feet wide, with openings between them of 170 feet, spanned by arches. Doubt has been thrown on the accuracy of this description, because the design shown in fig. 105 is obviously unsuited to a span of 170 feet; nevertheless thirteen piers are still visible out of the twenty, according to Murray's *Handbook*. The writer has not been able to find any accurate measurement of the width between these piers, but as the *Handbook* speaks of the length of the bridge as perhaps 3900 feet, and as the Conte Marsigli, writing from personal observation, in a letter to Montfaucon, gives the total length as probably 3010 feet, there can be no doubt that the spans were very considerable, and that the representation of the design in the bas-relief is almost wholly conventional. The one point as to which it gives clear information, not supplied elsewhere, is that the superstructure was of wood. The piers seem to have been founded by sinking caissons. Murray's *Handbook* gives the depth of the river as 18 feet. Apollodorus of Damascus was the architect of this remarkable bridge. The bridge at Rimini, built during the reign of Augustus, was especially admired by Palladio (Rondelet, *L'Art de bâtir*). The bridge at Narni, on the road from Loretto to Rome, also built by Augustus (Montfaucon), and the bridge of Alcantara over the Tagus, built in the reign of the Emperor Trajan, are often cited as remarkable works.

Trajan's Bridge.



Cross Section. Elevation.

FIG. 104.—Bridge of S. Angelo.

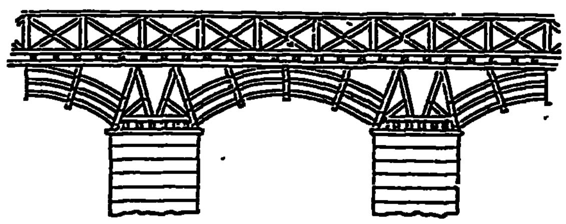


FIG. 105.—Trajan's Bridge.

Rimini

Narni.

Alcantara

The Romans frequently adorned their bridges with a triumphal arch. A small example of this kind of bridge at St Chamas, in France, is shown in fig. 106 (Cresy's *Encyclopædia of Civil Engineering*). The span of the arch is 42 feet, and the voussoirs are 3 feet 5 inches deep. Fig. 107 shows the bridge of Narses, built in the 6th century, and which carried the Via Salaria across the Anio or

St Chamas.

Ponte Salaro.

Teverone. This bridge was blown up during the panic caused by the approach of Garibaldi to Rome in 1867.

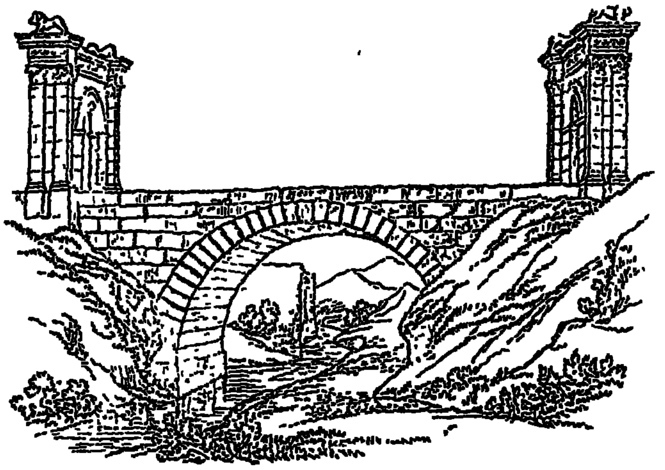


FIG. 106.—Bridge at St Chamas.

We see here, perhaps, one of the earliest examples of the castle built to protect the bridge against an enemy or to enforce payment of a toll,—the bridge and castle of mediæval romance.

§ 74. 1000 to 1300 A.D.—A very bold arch over the Serchio near Lucca is shown in plate 58 of Hann and Hosking's treatise, with the approximate date of 1000 A.D., but the authority for this date is not given. The span of the arch is 120 feet, and the roadway, which stands at a height of more than 60 feet above the water level, is only 9 feet wide; in fact the arch is little more than a broad wall. Owing chiefly to the excellence of the mortar employed, this arch withstood a flood which rose nearly 30 feet above the springing of the arch. This structure is one of the many "Devil's Bridges."

In the year 1178 a famous bridge was begun over the

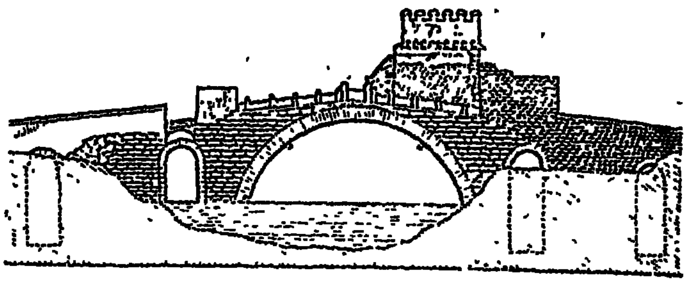


FIG. 107.—Ponte Salaro.

Rhone at Avignon by Saint Benezet, the head of one of certain religious confraternities, which undertook the building or repair of bridges during the Middle Ages, and were called Fratres Pontis or Hospitalarii Pontifices. The bridge was finished in 1188. Four arches still remain, and are remarkable in having an elliptical outline with the radius of curvature smaller at the crown than at the haunch, a form which accords more truly with the linear equilibrated arch than the modern flat ellipse with the largest radius at the crown. A description and drawing of this remarkable bridge will be found in the *Dictionnaire raisonnée d'Architecture* of M. Viollet-le-Duc.

A religious confraternity, founded in the first instance by a certain Mary, the maiden daughter of a ferryman, is said to have built a timber bridge near the site of the

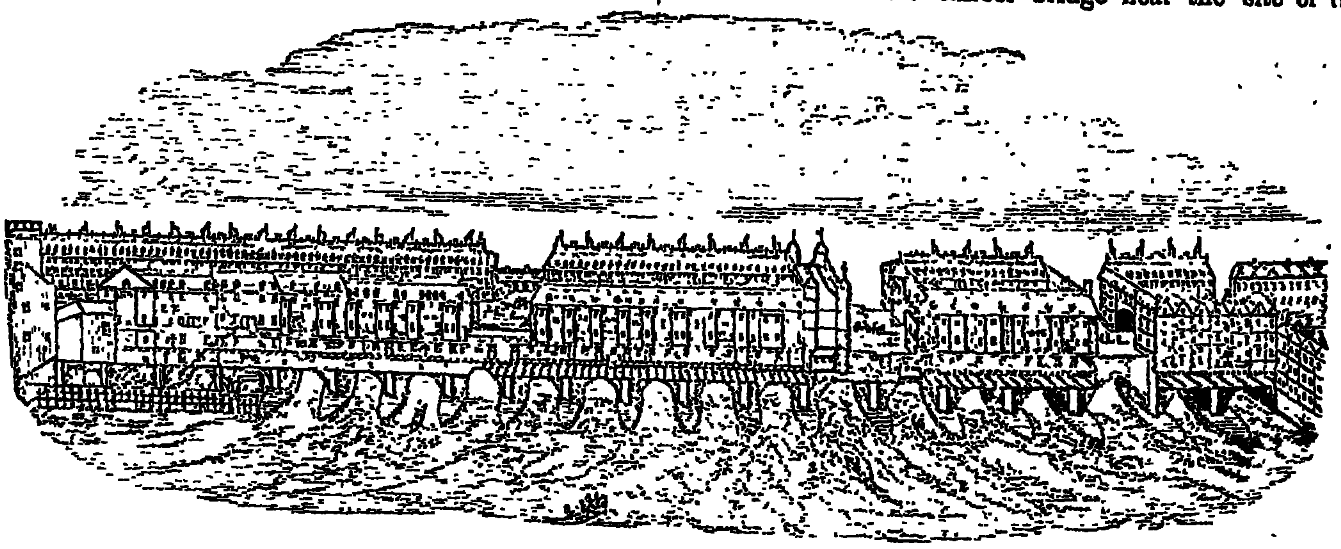


Fig. 108.—Old London Bridge, A.D. 1700.

present London Bridge, but it seems quite uncertain when the first bridge over the Thames was built. There is little doubt, however, that it was of timber, and had frequently to be reconstructed. Stow, in his *Survey of the Cities of London and Westminster*, gives a description of the building of the first stone structure, commonly called Old London Bridge, Plate XVIII. fig. 1.[1]

Heavy repairs were frequently necessary, and the timber houses built on the bridge were often burnt down; yet the main structure appears to have remained unaltered until the beginning of this century. It does not seem improbable that Peter of Colechurch and Saint Benezet may have been in communication with one another, both being heads of religious bodies engaged in similar works at the same time. Their letters to one another would interest engineers. A French brother Isembert, from Saintes, succeeded Peter as engineer for London Bridge.

Stow describes the partial rebuilding of the timber houses in 1645:—

"The building was of timber, very substantial and beautiful, for

[1] About the year 1176 the stone bridge over the river Thames at London was begun to be founded by the foresaid Peter of Colechurch (priest and chaplain before), "near unto the bridge of timber, but somewhat towards the west, for I read that Botolph's wharf was in the Conqueror's time at the head of London Bridge. The king assisted this work, a cardinal then being legate here; and Richard, archbishop of Canterbury, gave one thousand marks towards the foundation. The course of the river for the time was turned another way about by a trench cast for that purpose, beginning, as is supposed, east about Rotherhithe, and ending in the west about St Patricksey, now termed Battersea. This work, to wit the arches, the chapel, and stone bridge over the Thames at London, having been thirty-three years in building, was, in the year 1209, finished by these worthy merchants of London—Serle Mercer, William Almaine, and Benedick Botewrite, principal masters of work; for Peter of Colechurch deceased four years before the work was finished, and was buried in the chapel builded on the same bridge in the year 1205."

BRIDGES

Fig. 1. LONDON OLD BRIDGE.

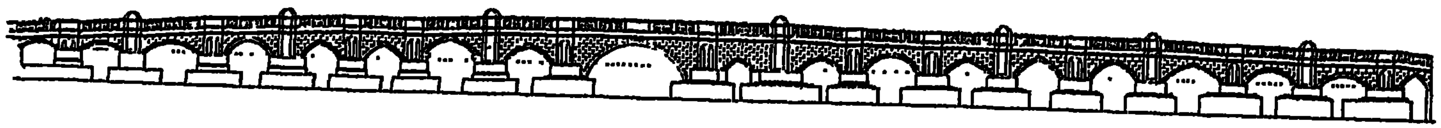


Fig. 2. LONDON NEW BRIDGE.

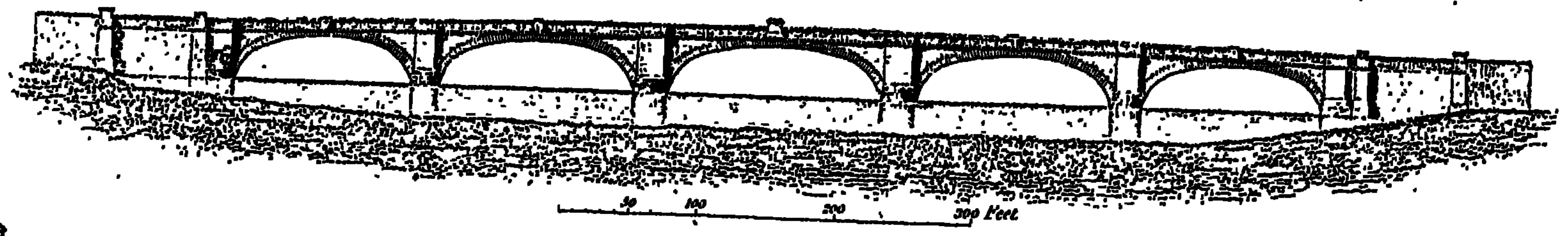


Fig. 3. WATERLOO BRIDGE.

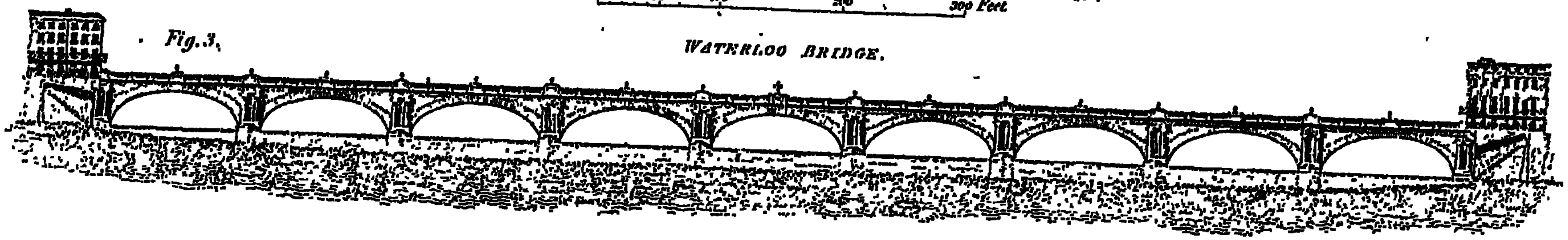


Fig. 4. SOUTHWARK BRIDGE.

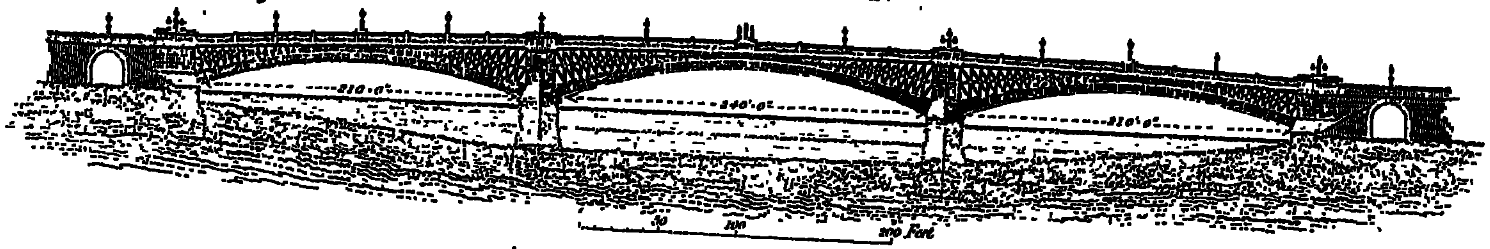
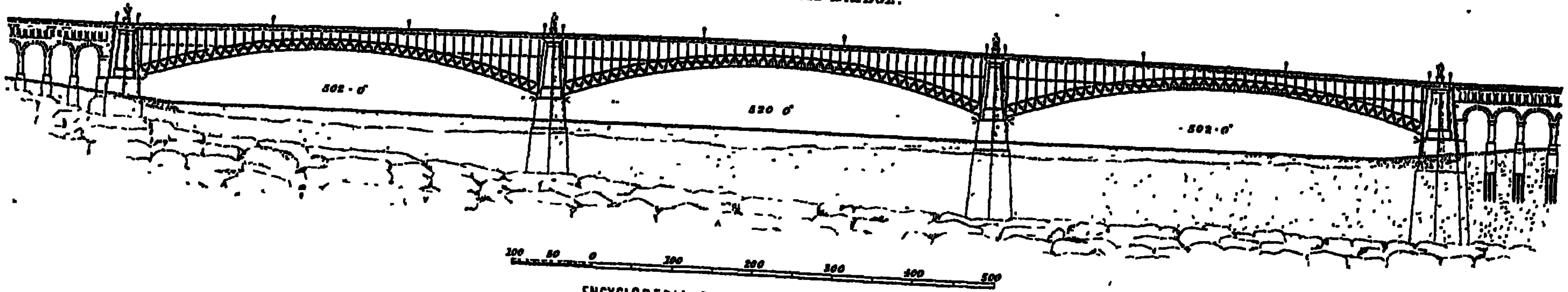


Fig. 6. ILLINOIS & St. LOUIS BRIDGE.



ENCYCLOPÆDIA BRITANNICA NINTH EDITION

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the houses were three stories high, besides the cellars, which were within and between the peers, and over the houses were stately platforms leaded with rails and ballasters about them, very commodious and pleasant for walking and enjoying so fine a prospect up and down the river, and some had pretty little gardens with arbours."

The passage between the houses was made 20 feet; previously it had been but 14 feet, and in some parts 12 feet. These beautiful houses were burned in 1666, when they were replaced by a still finer pile of buildings, with a *uniform roadway of 20 feet in width. Fig. 108 shows* the bridge as it appeared in 1700.

The piers varied in thickness from 25 to 34 feet, and were raised on strong elm-piles, covered with thick planks bolted together. The openings in the arches varied from 10 feet to 32 feet 9 inches. The whole waterway was 336 feet 9 inches, two-thirds of the stream being occupied by piers.

FIG. 109.—Croyland Bridge.

§ 75. 1300 to 1700 A.D.—The strange triangular bridge
land. at Croyland (fig. 109) is another example of a bridge probably built for or by a religious body. This structure stands at the confluence of the Welland, the Nyne, and the Catwater drain; three pointed arches, having their abutments at the angles of an equilateral triangle, meet in the middle, giving three watercourses and three roadways. Each arch has three stone ribs, and the nine meet in the centre. Croyland "triangular bridge" is alluded to in a charter of the year 943; from the character of the masonry the present structure is supposed to have been built in the
m. beginning of the 14th century. A bridge over the Trent at Burton, 1534 feet in length, and consisting of 34 arches, was also built by a religious community under Abbot Bernard.

es. Fig. 110 shows the old bridge at Saintes as M. Viollet-le-Duc considers that it appeared towards the end of the 14th century. The following description is abridged from his *Dictionnaire raisonnée d'Architecture*:—

"The first gate appeared on the right shore of the river, on the side of the Faubourg des Dames; next came the Roman arch, the upper part of which was crenelated during the Middle Ages; next on the side of the town stood a tower of oval plan, through which the road lay; the town gates with flanking towers closed the end of the bridge. From the first gate to the Roman arch the bridge was of wood, as was also the case between the great tower and the town gates, so that by the removal of this part of the roadway all communication could be cut off between the town and the tower as well as between the bridge and the Faubourg; moreover, the parapets were crenelated, so that the garrison of the town could at will stop all navigation."

Clearly it was quite as important in those days to be able to arrest as to facilitate communication between the two sides of the river.

The architects of the Renaissance showed great boldness
o. and originality in their designs. The largest arch known to have been built spanned the Adda at Trezzo, constructed by order of Bernabò Visconti, duke of Milan (latter half of 14th century. This bridge is described in Haun and Hosking's *Bridges* as having consisted of "a single arch of

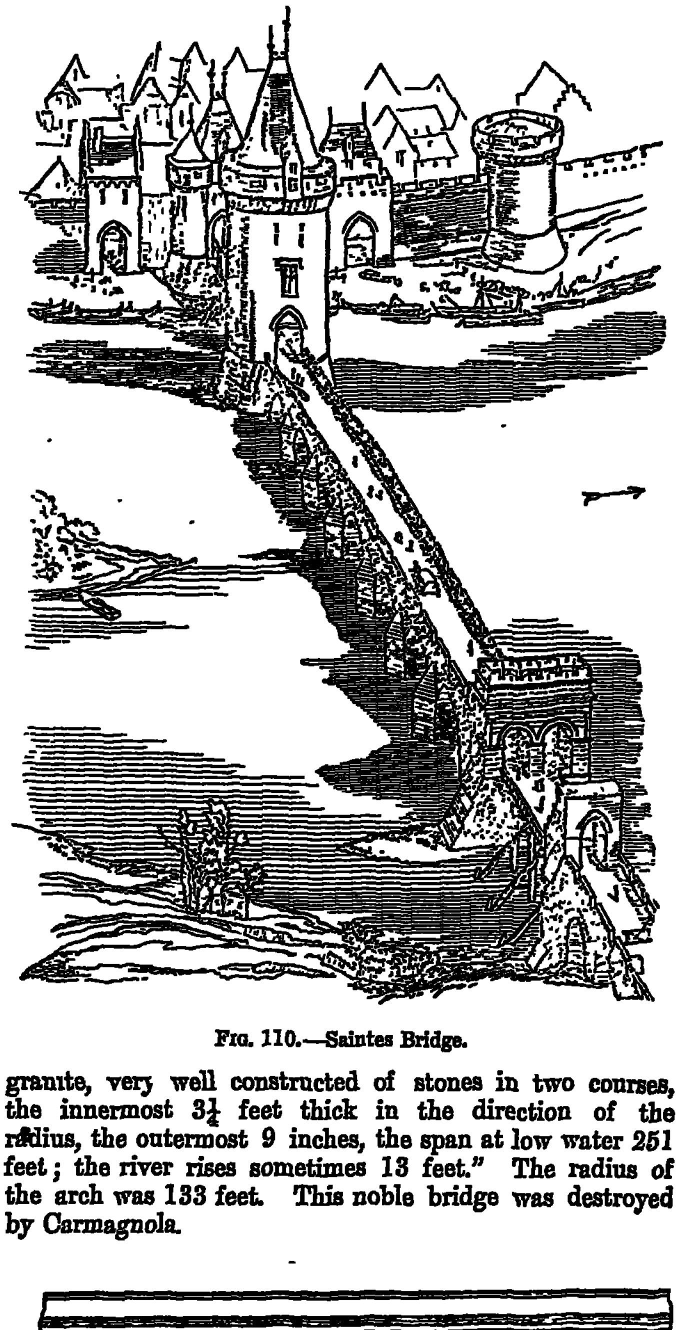


FIG. 110.—Saintes Bridge.

granite, very well constructed of stones in two courses, the innermost $3\frac{1}{4}$ feet thick in the direction of the radius, the outermost 9 inches, the span at low water 251 feet; the river rises sometimes 13 feet." The radius of the arch was 133 feet. This noble bridge was destroyed by Carmagnola.

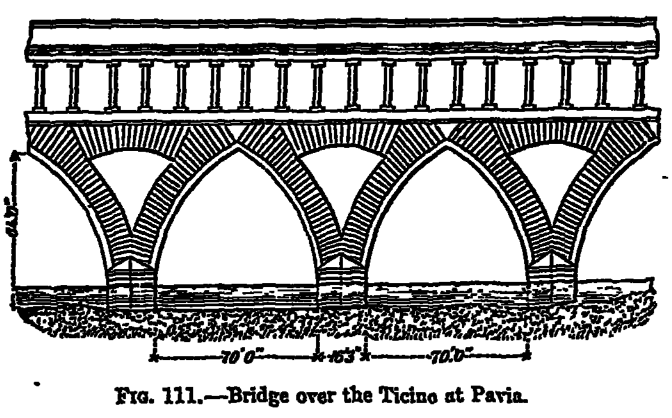


FIG. 111.—Bridge over the Ticino at Pavia.

The covered bridge over the Ticino at Pavia (fig. 111) Pavia.
was erected, under Gian Galeazzo Visconti, about the end of the 14th century. This bridge, which still exists, has seven pointed brick arches, each 70 feet in span and 64 feet in height; the depth of the arch ring at the crown is 5 feet 6 inches. The tympanum is pierced; the bricks used in

the arches are formed to suit their position, and are hollow

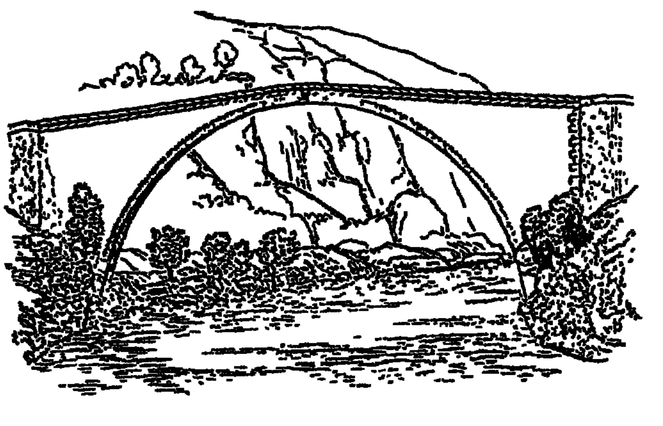


FIG. 112.—Bridge of Brioude.

in the middle to diminish the weight. The roof of the roadway is carried by 100 rough granite columns.

Brioude. Fig. 112 taken from Montfaucon's *Antiquité expliquée*, shows the old bridge of Brioude across the Allier in France. Montfaucon and Séguin speak of this as a Roman work, but Gauthey gives the date 1454 for its construction, and names Grenier and Estone as builders without giving his authority. The design of the bridge appears to favour the date given by Gauthey. The span was 183·73 English feet (Rennie, *Proc. I.C.E.*), the arch was a segment of a circle and the height 60 feet, while the width of the bridge was only 16 feet. This bridge fell in 1822.

Rialto, Venice. The bridge of the Rialto at Venice (fig. 113) was begun in 1588, Antonio da Ponte being the architect. The span of the arch is 91 feet, the height above the water level 24 feet 6 inches, and the width of the footway 72 feet. Erroneous statements are often met with that this bridge was built from a design by Michel Angelo; the mistake has arisen from the misinterpretation of a passage in the works of Vasari. Rondelet, in his *Essai Historique sur le Pont du Rialto*, gives a full account of the rival

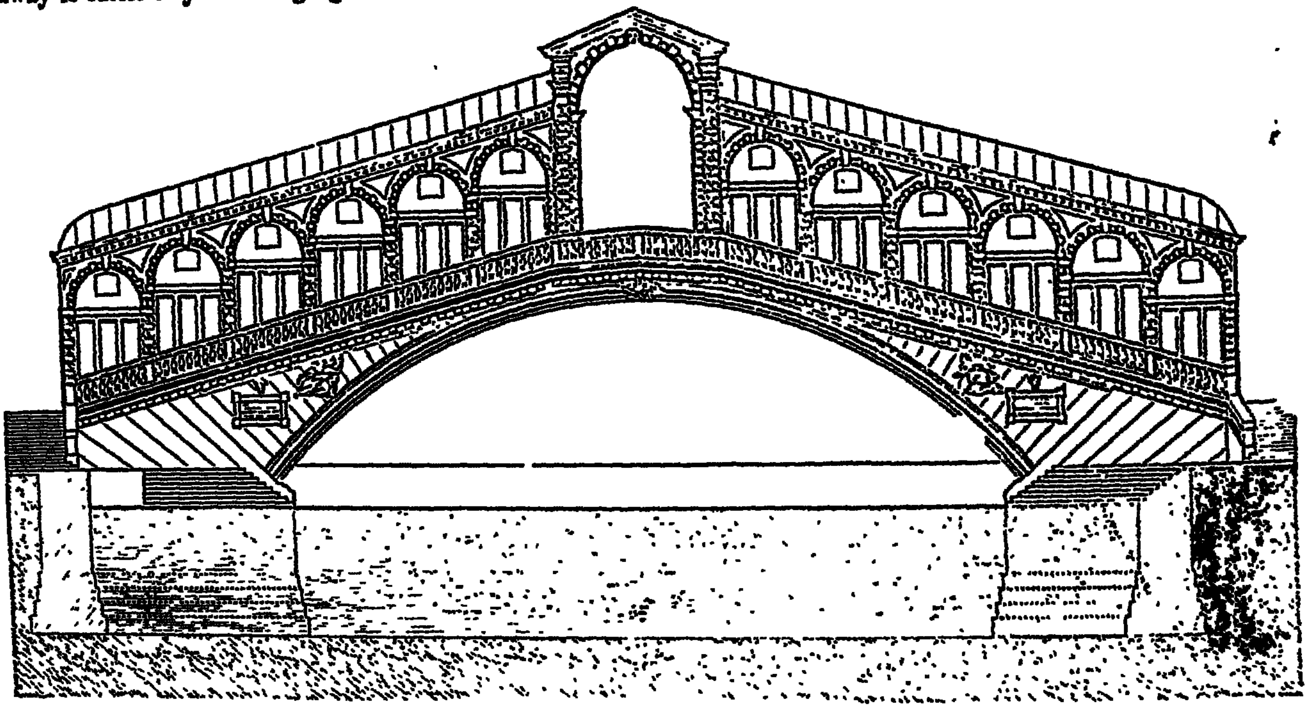


FIG. 113.—Bridge of the Rialto, Venice.

designs submitted to the senate by Antonio da Ponte and Palladio.

Florence. Ponte della Trinità. Fig. 114 shows the singularly beautiful "Ponte della Trinità," erected at Florence (1566) from the designs of Ammanati. Those who are curious in such matters may observe with interest the amended design for this bridge, given in Hosking's *Architectural Treatise on Bridge Building*, p. 241, which serves to show how easily a noble design may be spoilt by an alteration in the proportions of its parts.

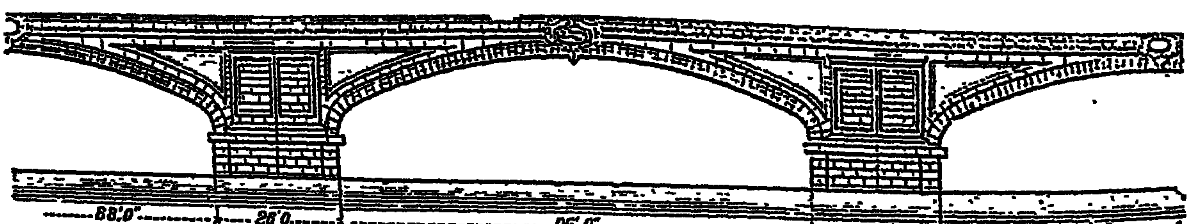


FIG. 114.—Ponte della Trinità, Florence.

York. A fine bridge over the Ouse at York, erected in the reign of Queen Elizabeth, was taken down some years ago; it is shown in fig. 115. The span of the largest arch was 81 feet (Allen), and the rise 26 feet 3 inches.

Pont Neuf, Paris. The well-known Pont Neuf at Paris was built in 1604. The design has no feature calling for special remark. Fig. 116 shows the bridge over the Conway at Llanrwst in Wales, the design for which was furnished by Inigo Jones in 1634. The middle arch has a span of 58 feet. The structure is easily set in vibration, and is known as the "shaking bridge." Further particulars concerning this and many other old English bridges will be found in Smiles's *Lives of the Engineers*, chap. iii. vol. ii., edition 1874.

Llanrwst.

Ispahan. A bridge over the Senderud at Ispahan is described as follows in Heck's *Iconographic Encyclopædia*, with illustrations:—"It (the bridge) is 2250 feet long, 120 feet high, and 156 feet broad; the middle way is 60 feet broad, and the sideways are paved with marble, and the latter lead through arcades, to which the ascent is by stairs

in the four towers of the bridge. The bridge has 29

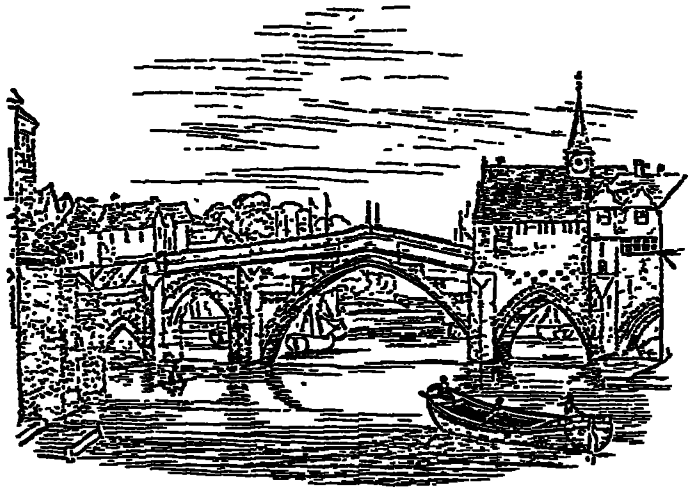


FIG. 115.—Old Bridge at York.

arches of 50 feet span, and the pillars are 25 feet thick.' In the illustration the arches are Moorish, and the covered sideways lofty, with 3 arches of small span over each main arch of the bridge. The design is remarkably fine. Heck calls it the bridge of Barbaruh, and states that it is named from its builder, but it is of unknown antiquity. All the bridges of Ispahan are said, in the 7th edition of the present work, to have been built under Shah Abbas I. (1585 to 1628).

Heck mentions a bridge at Loyang in China, said to have a length of 26,800 feet, and another at Focheu 22,000 feet long, both from 60 to 70 feet wide.

West-ster Black-rs dges.

§ 76. 1700 to 1817.—Old Westminster Bridge (Labelye) and Old Blackfriars Bridge (Mylne), both of which have now been removed, were built in the middle of the 18th century. Their failure after so short a period was due to a defective system of foundation and to the increased scour caused by the removal of old London Bridge.

it-y-tu ydd.

The Pont-y-tu-Prydd over the River Taff near Newbridge is shown in fig. 117. The arch measures 140 feet between the abutments, and has a rise or versed sine of 35 feet. The width of the soffit is 15 feet 10 inches at the springing, diminishing to 14 feet 5 inches at the crown by six offsets on each face. The roadway is 11 feet wide over the centre

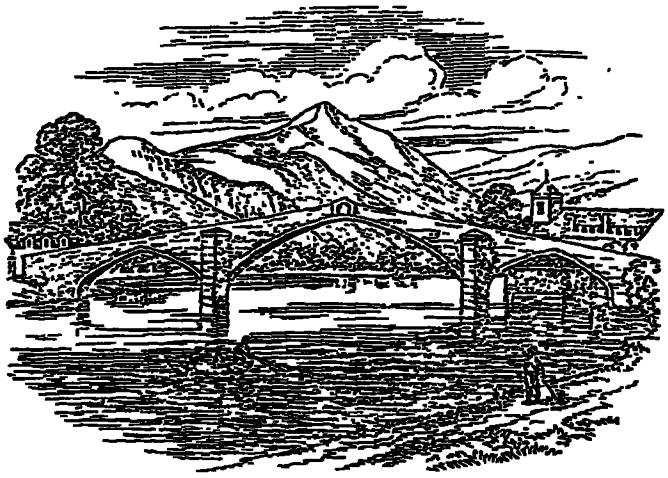


FIG. 116.—Llanrwst Bridge, Wales.

of the arch. The arch stones on the face are 2 feet 6 inches

FIG. 117.—Pont-y-tu-Prydd.

deep, the rest of the ring being rubble masonry. This

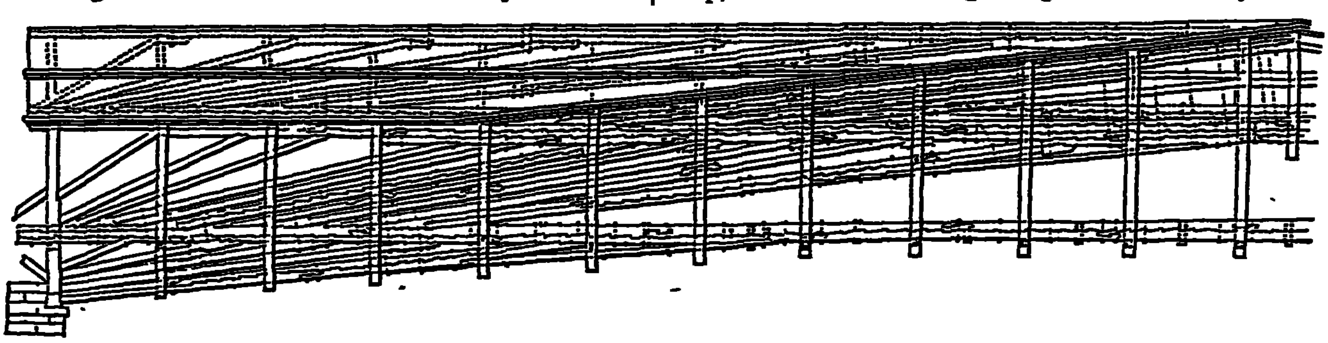


FIG. 118.—Half Truss of Wittingen Bridge.

bridge was built by William Edwards, a self-educated country mason. It was completed in 1750 after the failure

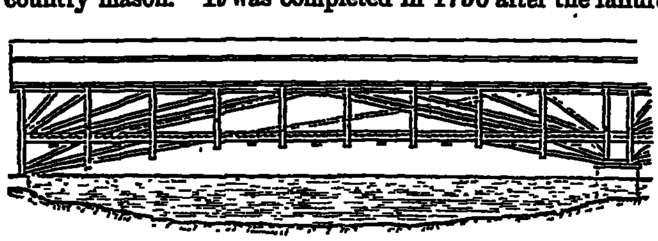


FIG. 119.—First Arch of Schaffhausen Bridge.

of a similar structure, in which the weight of the haunches was excessive and forced up the crown, the depth of which was very small. This failure led to the adoption of the pierced spandrils.

Fig. 118 shows half of the truss for the bridge of Wittingen, built in 1758 by the brothers Grubenmann, probably the finest specimen of a wooden bridge that has ever been constructed; the design might be analyzed as consisting of a series of superposed trusses, as in fig. 87, which represents the bridge at Schaffhausen built by the same engineers or village carpenters. The Schaffhausen bridge (fig. 119), destroyed by French troops in 1799, had two openings, one of 172 feet and the other 193 feet. The Wittingen bridge, burnt shortly afterwards, had a span

Wittingen

Schaff-hausen.

of 390 feet, being the largest opening ever spanned by wood.

Mr Smiles states that the first attempt to build a cast-iron bridge was made in 1755 at Lyons, and that one of

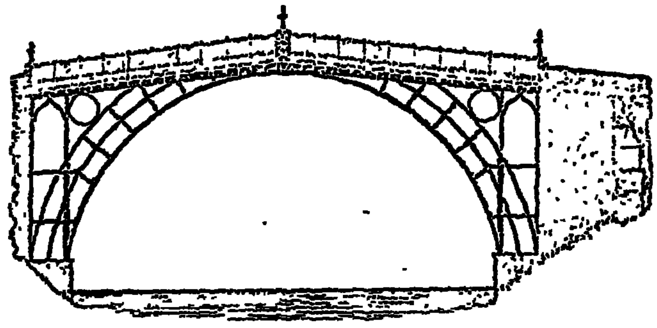


Fig. 120.—Coalbrookdale Bridge.

the arches was put together in a builder's yard, but that the project was abandoned as too costly. Mr Abraham Darby, the owner of iron-works of Coalbrookdale, was the first person who actually erected a cast-iron arch. This bridge (fig. 120) crosses the Severn by a span of 100 feet, near the town of Ironbridge, which has sprung up in the neighbourhood. Each of the ribs consisted of two pieces. The design is a bold and original one, and has been practically successful. Wearmouth Bridge, completed in 1796, is an arch built of open cast-iron panels, acting as voussoirs; the span is 236 feet, with a rise of 34 feet; the springings begin 95 feet above the bed of the river; and the width of the bridge was 32 feet. It contained 214 tons of cast-iron and 46 tons of wrought iron. The name of Thomas Paine, the well-known author, has been associated with the design of this bridge; but Mr L. D. B. Gordon (first Professor of Engineering in Glasgow) assures the writer that after careful investigation he finds that Rowland Burdon, member for the county, was engineer, architect, and paymaster for this remarkable bridge. It was repaired and widened by Robert Stephenson in 1858. The bridge erected by Coalbrookdale.

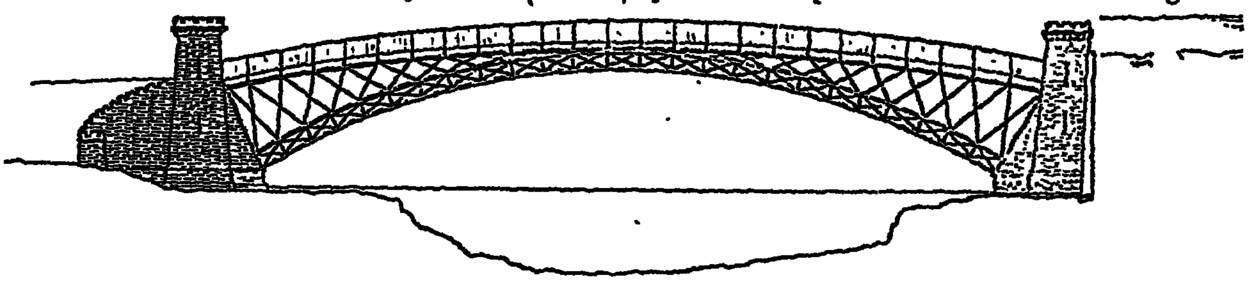


Fig. 121.—Cast-Iron Bridge at Craigellachie.

Telford at Craigellachie (fig. 121), over the Spey, in the beginning of this century, shows a great advance in the conception of what was the safest form in which to apply cast-iron to an arch.

§ 77. 1817 to 1845.—*London Bridge and Waterloo Bridge.*—London new bridge (fig. 40, *supra*, and Plate XVIII. fig. 2), is as fine an example of the modern stone arch bridge as can be found. The shape of the arches, the variation in their span, the slight curvature of the roadway, and the simple yet bold architectural details, are combined so as to produce a singularly beautiful structure. It is now insufficiently wide for the traffic it has to convey, but all who value beauty must earnestly desire that it may not be disfigured by having overhanging footpaths fitted to it as has been frequently proposed. London can well afford to pay for new bridges, but can by no means afford to part with a single object of real beauty.

The design was made by Mr George Rennie, and the acting engineer was his brother, Sir John Rennie. The centre arch has a span of 152 feet, and rises 29 feet 6 inches above Trinity high water mark; the arches on each side of the centre have a span of 140 feet, and the abutment arches 130 feet. The total length of the bridge is 1005 feet, its width from outside to outside 56 feet, and height above low water 60 feet. The two centre piers are 24 feet thick, the exterior stones are granite, the interior, half Bramley Fall and half from Painshaw, Derbyshire.

The voussoirs of the centre arch (all of granite) are 4 feet 9 inches deep at the crown, and increase to not less than 9 feet at the springing. The general depth at which the foundations are laid is about 29 feet 6 inches below low water. Seven years and a quarter were spent in the construction of London bridge, which was opened in 1831. The total cost was £1,458,311, but the contractor's tender for the bridge alone was £425,081.

Waterloo Bridge, Plate XVIII. fig. 3, is another fine structure of the same character (1817).

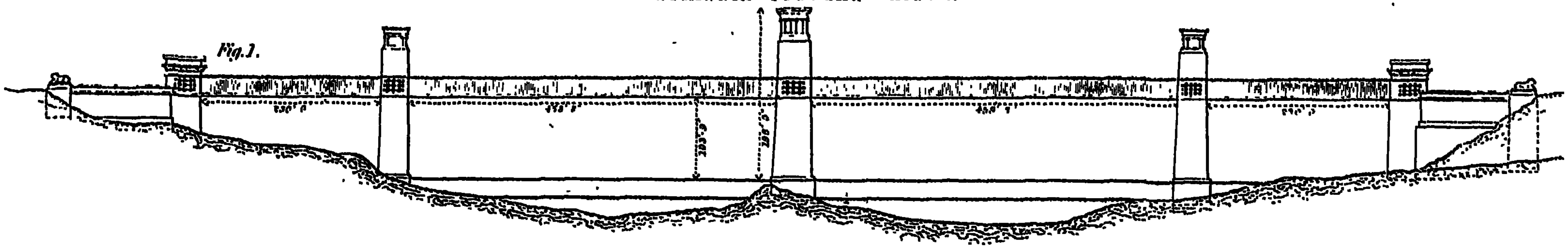
Introduction of Suspension Bridges.—It will be observed that from the earliest ages in which we have records of the construction of permanent bridges until very lately, the stone or brick arch has been the structure principally relied on. Timber bridges more or less permanent have also been employed for great spans, as in the noble bridges erected by the brothers Grubenmann (1757); and after the construction of the bridge at Coalbrookdale (1777) cast-iron was not unfrequently employed in England. The theory of the metal arch was, however, very imperfectly understood, and the great metal arch of Southwark bridge (completed 1819), Plate XVIII. fig. 4 (largest span 240 feet), is little more than a heavy and wasteful imitation of a stone ring. By the use of timber or cast-iron instead of stone, the opening which a bridge could span was, however, somewhat increased. An immense stride in this direction was made when suspension bridges were introduced. A bridge of this kind over the Tees, 70 feet in length, was built in 1741 for the use of miners. Similar bridges are also said to have been used by Mr Finley in America, but the introduction of the modern suspension bridge practically dates from about 1820. (Galashiels bridge, 112 feet in length, was constructed in 1816, also a bridge of similar dimensions at Peebles over the Tweed). In 1819 Telford began the construction of the Menai suspension bridge (Plate XIX. fig. 2), in which the span of the catenary is 570 feet and the dip 43 feet. The success of this structure led to the construction of many other large suspension bridges, as at Fribourg (span 870 feet), Hammersmith (span 422 feet), Pesth (span 666 feet). This form of bridge was not, however, found suitable for railway traffic; and on the introduction of railways engineers were for many years dependent on stone, brick, or cast-iron arches.

Southwark Bridge. Tees Bridge. Galashiels. Peebles. Menai Bridge.

§ 78. *Britannia Bridge*, 1845.—The design by Robert Stephenson of a bridge to carry the Chester and Holyhead Railway across the Menai Straits led to a complete revolution in engineering practice. Mr Stephenson's first conception was that of a tube partly carried by chains. This would have practically been a suspension bridge stiffened by a girder. Under Mr Stephenson's direc- Britannia Bridge.

BRITANNIA TUBULAR BRIDGE.

Fig. 1.



MENAI SUSPENSION BRIDGE.

Fig. 2.

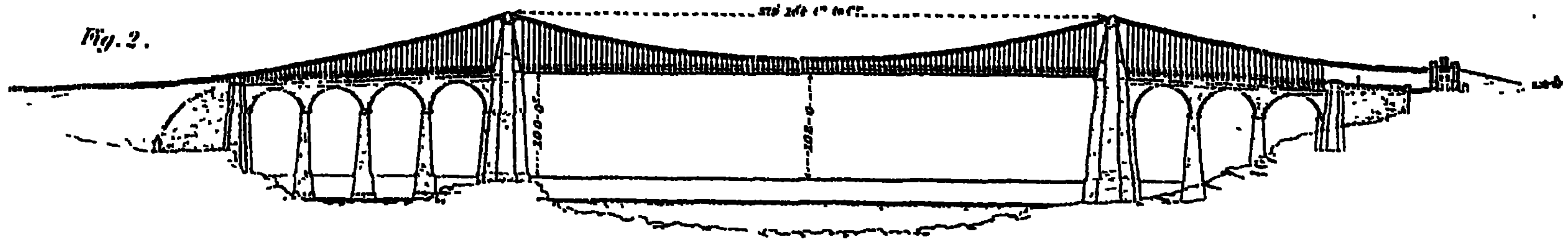


Fig. 3.

HIGH LEVEL BRIDGE NEWCASTLE.

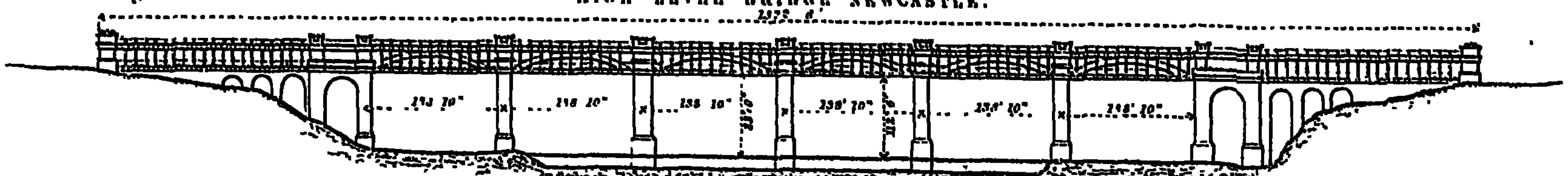


Fig. 4.

CRUMLIN VIADUCT.
South Wales.

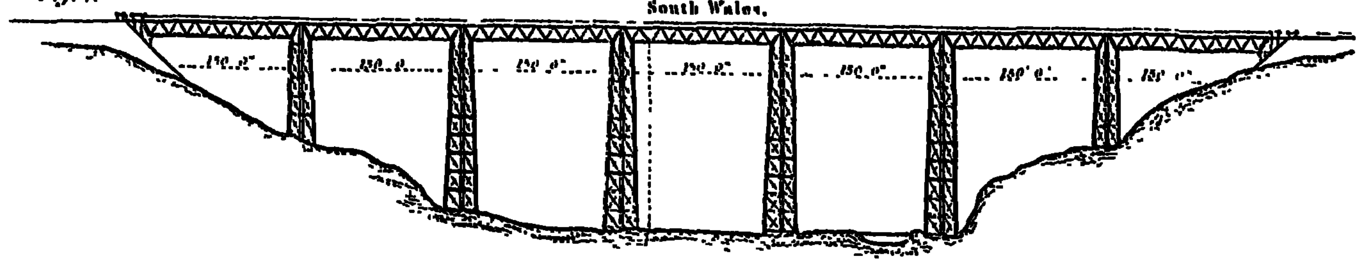
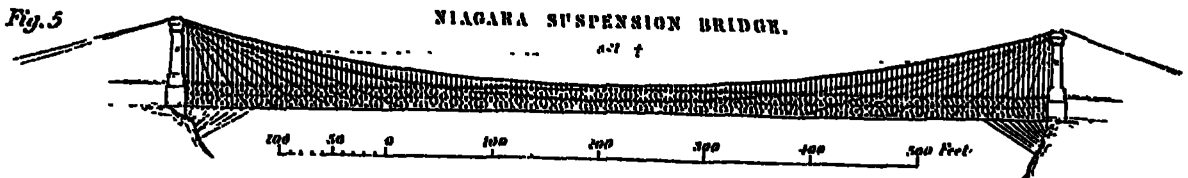


Fig. 5

NIAGARA SUSPENSION BRIDGE.



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tions, experiments and calculations on the strength and best form of tubes were made by Mr William Fairbairn (Sir William Fairbairn) and Mr Eaton Hodgkinson. In the course of the experiments it was found that the tube could be made self-supporting over the desired span of 460 feet; and in consequence of this discovery the Conway and Menai tubular bridges were built, being the first great examples of properly designed girders. Some disputes arose as to the real inventor of these bridges. Sir William Fairbairn justly claimed the great merit of first perceiving that the girder might be self-supporting. Mr Hodgkinson had, perhaps, the smallest part in the design, but the shares of Fairbairn and Stephenson respectively cannot be very rigorously apportioned; nor is this now of much consequence.

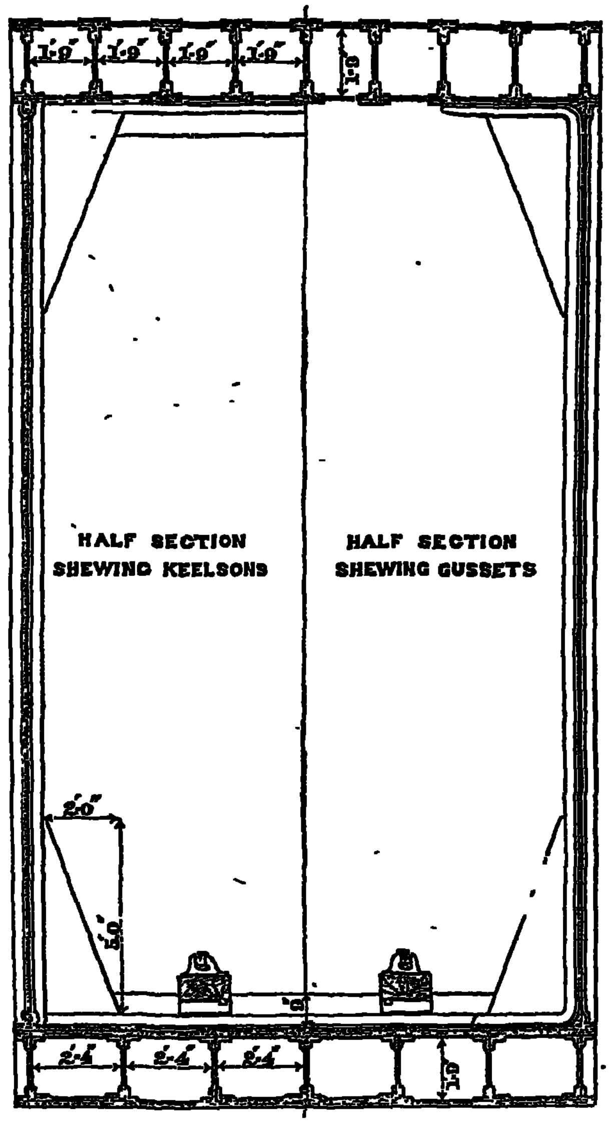

FIG. 122.—Britannia Bridge (Cross Section of Tubular Girder).

Both engineers were men of extraordinary merit, and co-operated in producing the great revolution in practice which has led to the adoption of the wrought iron girder as the most common type of bridge. The first train passed through the Britannia Bridge in 1850. The following description of the structure appeared in the 8th edition of the present work. It will be seen that this description is to some extent a defence of the design against criticisms asserting that the structure was unnecessarily heavy and costly. It is true that a considerably lighter bridge could now be built, but some prudence in introducing so great a novelty was certainly commendable.

"The Britannia Bridge which carries the Chester and Holyhead Railway over the Menai Straits (figs. 122 and 123, and Plate XIX. fig. 1) consists of two independent continuous wrought iron tubular beams, 1511 feet in length, and weighing 4680 tons each, independent of the cast-iron frames inserted at their bearings on the towers. They are 15 feet wide, and vary in depth from 23 feet at the ends to 30 feet at the centre. They rest on two abutments and three towers of masonry at a height of 100 feet above high water. The roadway is laid along the bottom, viz., one line of rails in each tube. The centre or Britannia tower, which is altogether 230 feet high, is built on a rock in the middle of the Straits. The bridge has thus four spans, viz., two spans of 460 feet over the water, and two spans of 230 feet over the land. On each side the weight of a single span of 470 feet is 1587 tons, and of a span of 242 feet 630 tons. These tubes repose solidly on the centre tower, but repose on roller beds on the land towers and abutments. Now, these gigantic dimensions are by no means the only remarkable features in this work. The opponents of the Holyhead Road had imposed conditions on the Chester and Holyhead Railway which were thought insurmountable with respect to this bridge. The navigation was not to be interrupted—no scaffolding could thus be used—and the clear height of 100 feet was to be retained throughout,—

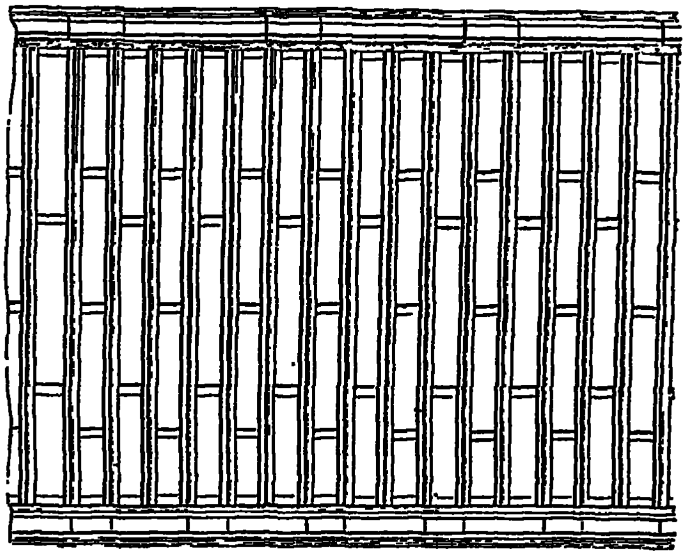

FIG. 123.—Britannia Bridge (Part Elevation of Tubular Girder).

arches being objected to unless the springing and not the centre was at this elevation. The tides set through this portion of the Strait with a velocity of 9 miles per hour, and the quiet water at each turn of the tide lasts but for a very short space of time. The tubes were designed to meet all these requirements; they were so constructed at a considerable distance from their permanent site on the shores of the Straits; they were floated upon pontoons upon these rapid tides to the base of the towers; and they were then drawn up by hydraulic presses to their required height. They were here united through the towers by the insertion of shorter lengths, and ultimately brought into the condition of continuous beams as regards strain, by the means employed for their junction. It is evident such structures would be designed specially for such varied circumstances, for example:—

"As soon as they were completed on temporary platforms, these platforms were removed, and they became isolated beams; the ends were accordingly strengthened with cast and wrought iron framing for this special object, and had they always remained there the sides might have been throughout considerably lighter than they are; they now weigh nearly 40 per cent. of the whole weight. But in the next operation, that of floating, the tubes were liable to be supported at *any point* of their length, besides being subjected to chances of considerable distortion, and to disasters

which on more than one occasion did actually threaten their entire destruction. The stiffening frames and gussets, which in an ordinary girder would have only been necessary at the ends, became therefore necessary throughout the whole length, and even the top and bottom were considerably modified, as it is evident that while overhanging the pontoons on each end to the extent of 70 feet, the top, instead of being in compression was thrown into extension; the weight of the tubes was consequently much increased by these arrangements. Again, they had to be raised by being suspended freely from four chains. Provision for this suspension from such limited attachment had also to be made of a totally opposite character from that made for their vertical support when on their bed; and, ultimately, when raised to their place, they remained no longer independent beams, but were converted into continuous beams, parts before in tension being now thrown into compression, and *vice versa;* while the ends which were before subject to no horizontal strain were now exposed to greater strain than even the centre of the span. And, last of all, during the act of raising one of these enormous masses, the press from which it was suspended burst, and one end of the beam fell through a space of no less than 9 inches on to a loose uneven heap of planks beneath it, bulging in the bottom plates, breaking all the castings, distorting seriously the sides and stiffening frames; while the broken press itself, which descended from a height of about 100 feet above, broke through the top plates and completed the crippling of the whole section of support. It may surely be doubted whether anything but a tube could have stood such unexampled violence; and in proportioning the parts of a structure destined for such usage, the mere consideration of the strain to which as an ordinary beam it would be subjected, formed but a part of the problem; no direct comparison can therefore be made between the weight of this bridge and an ordinary beam. If this were the case with the large spans, it is still more so with the small spans of 230 feet, which as simple beams would weigh only 230 tons each, whereas their actual weight is 650 tons. But it must be borne in mind that as regards the bridge itself these small spans were not required at all, and that they were merely designed and used as counterpoises for

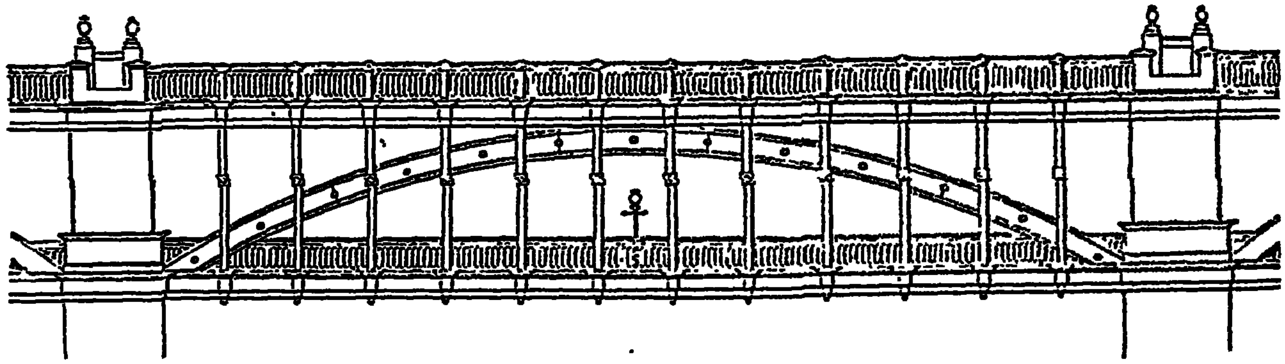

FIG. 124.—Elevation of Bowstring Arch, High-Level Bridge, Newcastle

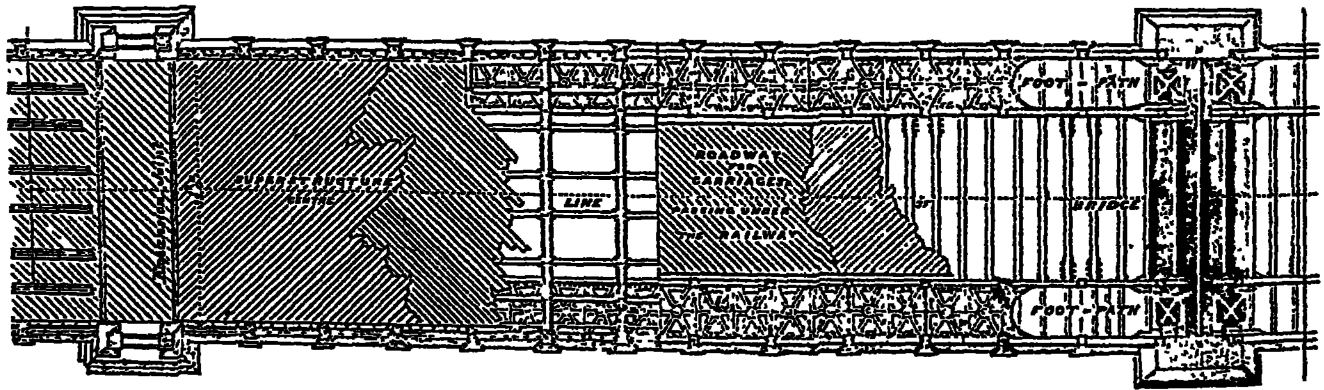

FIG. 125.—Plan of High-Level Bridge, Newcastle.

the large tubes, for the important purpose of converting them into continuous beams by their overhanging weight. By examining their detail, it will be found they are designed solely for this special purpose, their use as beams being made entirely subsidiary.

"Some misapprehension exists on the object and importance of the cells of which the top and bottom of these tubes is composed. These cells are rectangular, there being eight of them in the top and six of them in the bottom, and they run throughout the bridge. With respect to their importance, it must be observed that the whole section of the top of the Britannia tube at the centre is 648·25 square inches, and of the bottom 585·43 square inches, and that the tube is 15 feet wide; the thickness of a single plate to ensure this section would therefore have been 2·7 inches for the top, and 2·3 inches for the bottom; and had such a plate been procurable, nothing better could have been desired, and the cells would be unnecessary. Such a thing, however, is evidently impossible, and the engineer in this, as in numberless other details, had to adopt what he could obtain; now the arrangement of the plates in cells is almost the only conceivable arrangement possible for obtaining the required section, allowing access, at the same time, to every part for construction and future maintenance. This alone led to their use in the bottom of the tube, where their form was totally unimportant. With respect to the top, however, it was of great importance, since thick plates could not be had, to ascertain the best form of cell for resistance to compression that could be devised with thin plates. A series of valuable experiments by Mr Eaton Hodgkinson led to the use of the rectangular cells as actually used, not because such form presented any peculiar advantage over any other form, as some have imagined, but because these experiments demonstrated that cells of that magnitude and thickness were independent of form, and are crushed only by the actual crushing of the iron itself; under these circumstances, the square cells were used as the best practical method of obtaining the sectional area required.

"Similar misapprehension also exists as to the considerations which led to the rectangular form of the tubes

themselves. Now, the result of direct experiments made with round, oval, and rectangular tubes—there being precisely the same section and weight in all three, and, consequently, different depths—was, that the circular tube was the weakest, and the oval tube the strongest, the rectangular form being intermediate. The oval tube was, indeed, first studied with a view to its use. Its form, however, was not favourable,—neither for its actual construction, nor for its connection with the suspension chains which were

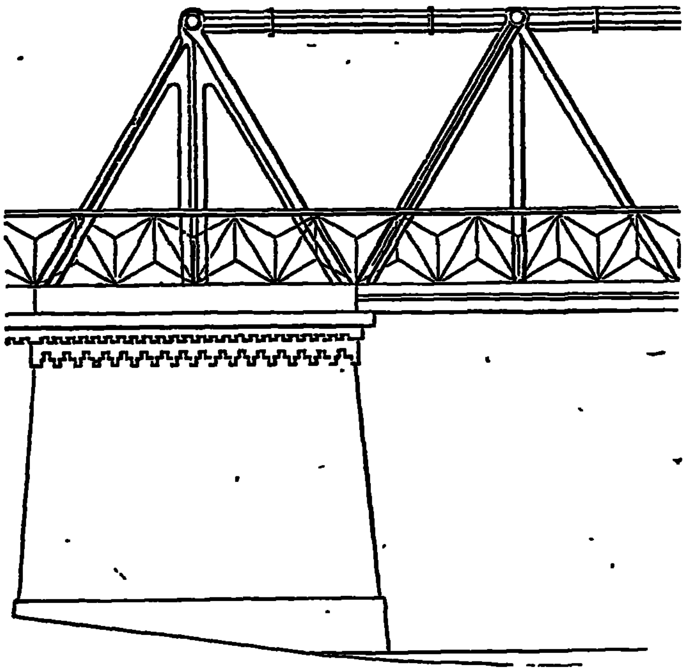

FIG. 126.—Newark Dyke Bridge.

originally intended to be used in the erection; and practical considerations, in this case, also compelled the use of the

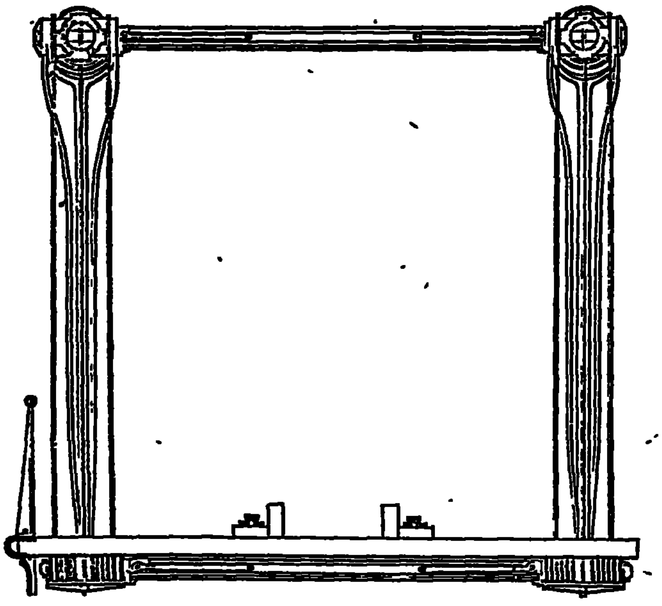

FIG. 127.—Section of Newark Dyke Bridge.

rectangular tube. It must also be remarked, that the result of experiments made on round, oval, and rectangular wrought iron tubes, when reduced to the same depth and compared, was in favour of the rectangular form, although within ordinary limits the form was not proved to be a matter of very great importance. It may be added, that this bridge has now been in use six years, that the deflection has been carefully tested, from time to time, with the utmost precision, and that not the slightest perceptible increase has taken place during that period. The care with which the painting has been attended, and the protection afforded by the roof, have also entirely preserved it from the slightest damage by oxidation; and it is difficult to conceive that even the lapse of centuries can in any way affect such a structure, or to doubt that it will remain one of the most durable, as it certainly is one of the most remarkable monuments of the enterprise of the present century."

§ 79. *Newcastle High-Level Bridge. Newark Dyke Bridge. Crumlin Viaduct.*—The High-Level Bridge at Newcastle (figs. 124 and 125, also Plate XIX. fig. 3) is a fine example of the true bowstring arch, in which there is no cross bracing. This bridge is also described at great length in the 8th edition; but the type cannot be recommended for imitation, being essentially more expensive and heavier than a true girder. The bridge was opened by the Queen in 1849. The design was therefore made almost at the same time as that for the Britannia Bridge, and is chiefly interesting as showing a transitional form intermediate between the arch and beam. The bridge has six spans, each of 125 feet, and the superstructure is supported on stone piers and abutments, the height to the soffit above high water being 83 feet. The arched ribs are cast-iron, and the ties wrought iron. 4728 tons of cast-iron and 321 tons of wrought iron were employed in the superstructure. There are two roadways, the carriage roadway passing under the railway. The bridge cost £243,000. Newcastle High-Level Bridge.

The solid or continuous plate girder soon led to the introduction of open frames, designed on similar principles.

Newark Dyke Bridge (the earliest example of a Warren girder bridge) carries the Great Northern line over a branch of the Trent near Newark. It was erected (1851–53) under the direction of Mr Joseph Cubitt from the designs of Mr Charles Wild. Newark Dyke Bridge.

This bridge (figs. 126 and 127) consists of four independent girders, viz., two for each line of railway. The roadway is beneath the girder. The top flange of each girder consists of a series of cast-iron pipes butting end to end; the

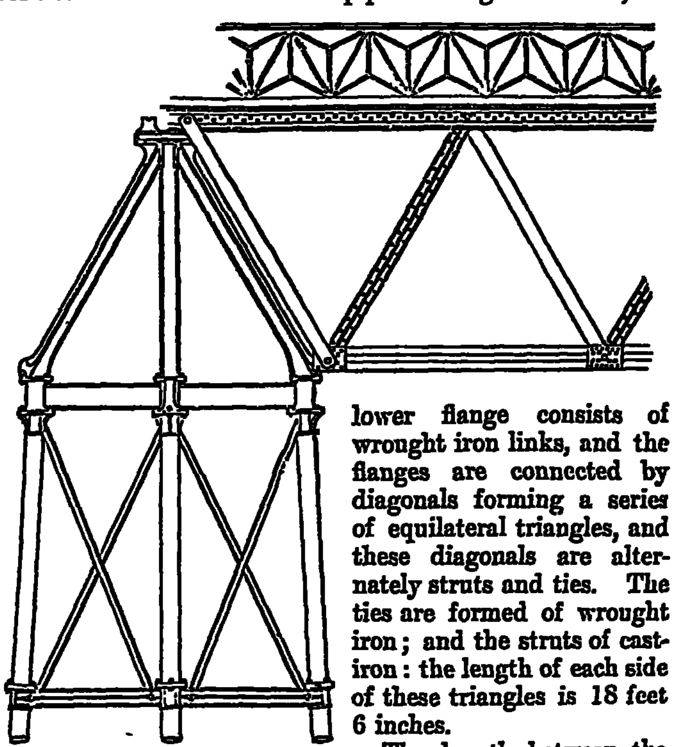

FIG. 128.—Part of Crumlin Viaduct.

lower flange consists of wrought iron links, and the flanges are connected by diagonals forming a series of equilateral triangles, and these diagonals are alternately struts and ties. The ties are formed of wrought iron; and the struts of cast-iron: the length of each side of these triangles is 18 feet 6 inches.

The length between the supports is 259 feet, and the depth from centre to centre of the joint pins is 16 feet. The clear span between the abutments is 240 feet 6 inches.

The weight of iron is 244 tons 10 cwt., of which 106 tons 5 cwt. is wrought iron, and 138 tons 5 cwt. cast-

iron, to which must be added 50 tons for the platform, making the total weight of each bridge 294 tons 10 cwt. The cost, exclusive of the masonry of the abutments, and of the permanent rails, but inclusive of the staging for fixing and the expense of testing, was £11,003.

Crumlin Viaduct. The Crumlin Viaduct, begun in 1853, and completed in 1857 (fig 4, Plate XIX.), is a fine example of the Warren girder; it was erected on the Taff Vale Extension Railway under Messrs Liddell and Gordon as engineers, by Mr T. W. Kennard as contractor. The following description is compiled from that given in Mr Humber's work:—The length of the bridge is 1800 feet, divided into two parts, one consisting of seven spans of 100 feet, and the other of three similar spans. The greatest height of the road-way above the surface of the water is not less than 200 feet. The piers are formed of cast-iron hollow columns, each 17 feet long and 1 foot in diameter; the thickness of the metal varies from 1 inch to ⅞th inch; *these columns are arranged* in tiers, each containing *fourteen columns*, the distance *between which at the base* of the pier measures 13 feet 6 inches, excepting between the centre rows, where it measures 6 feet throughout the height. The wrought iron girders are *150 feet in length* and 14 feet 6 inches deep. Some details of the construction are shown in fig. 128.

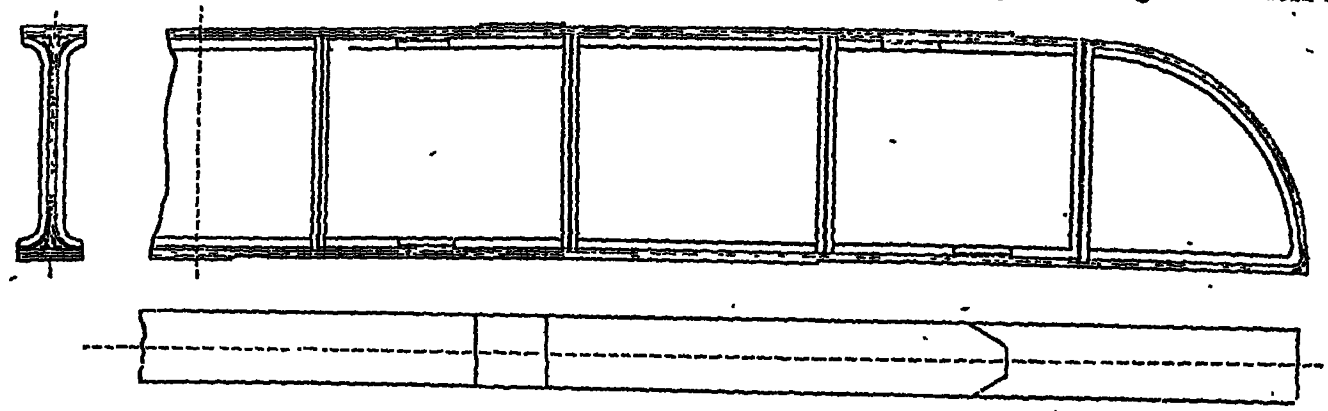

FIG. 129.—Common type of Wrought Iron Girder.

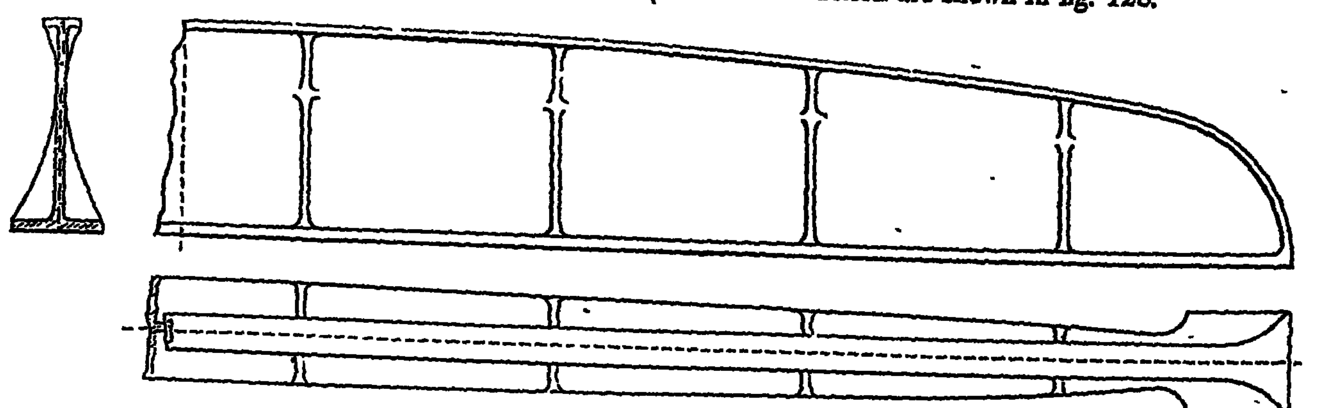

FIG. 130.—Common type of Cast-Iron Girder.

Fig. 129 shows a plan and elevation and *cross section* for half a wrought iron girder of a usual type *for small* spans. Covering plates are used to connect the *main plates* of the top and bottom webs, and stiffening angle irons are shown at the sides.

Similarly, fig. 130 shows a plan and elevation of a cast-iron girder of a usual type.

§ 80. *Niagara Suspension Bridge.*—Fig. 5, Plate XIX., shows Niagara Suspension Bridge, a structure described as follows in the 8th edition:—

"It crosses the Niagara River at a height of 245 feet above the water by a single span of 821 feet 4 inches, and forms the connecting link between the American States and Canada.

"The superstructure may be best described as a hollow rectangular box, 18 feet deep and 24 feet wide, on the top of which the railway is laid, while the bottom, which is 25 feet wide, forms the roadway for public traffic—both these floors are constructed of timber beams; and each connecting side consists of a row of double posts or uprights of timber, each pair being 5 feet apart; between them wrought iron diagonal bars are made to pass, extending each way to the fourth pair of posts at an angle of 45 degrees. The upper or railway floor is suspended from two wire cables at intervals of 5 feet, and the lower floor is suspended at similar intervals from two other wire cables which have a deflection of 10 feet more than the upper ones; these cables, four in number, are each 10 inches in diameter, and composed of seven strands, each containing 520 wires, making a total of 3640 wires. One strand forms the axis round which the other six are twisted. Sixty wires are equal to 1 square inch of solid section; therefore the total area of each cable is 60·4 square inches, or the total sectional area of iron supporting the structure is 241·6 square inches.

"Each cable rests upon a separate saddle, there being two on the top of each of the four towers. The saddles are placed on *ten cast-iron* rollers, 5 inches diameter and 25¼ inches long, which bear upon cast-iron plates 8 feet square and 2½ inches thick, strengthened by three parallel flanges which form two compartments for the reception of the saddles.

"The ends of the cables are attached to cast-iron shoes, in each of which is inserted a wrought iron pin which forms the *connection* with the anchor chains. These anchor chains are each embedded in a solid shaft of masonry 7 feet by 3 feet, enlarged at the bottom to form a chamber 8 feet square cut in the rock. The shafts are sunk to a depth of 25 feet on the New York side, and 35 feet on the Canada side.

"Each anchor chain is composed of nine links, the eight lower links being 7 feet long, and the ninth or uppermost 10 feet long. The lowest link consists of seven wrought iron bars, 7 inches by 1·4 inches each, and amounting

collectively to an area of 69 square inches. They are secured to a cast-iron anchor plate, by a pin $3\frac{1}{2}$ inches diameter. From the fourth link the chain curves, and the section is gradually increased to an area of 93 square inches. There are two towers at each end of the bridge, based upon a mass of masonry 60 feet by 20 feet, which is pierced by an arch 19 feet wide, forming the entrance to the lower roadway. The towers are 60 feet high, 15 feet square at the base, and 8 feet square at the top.

"Above the floors are 64 diagonal stays, extending from the saddles to the suspenders, amongst which they are equally distributed; they are formed of wire-rope $1\frac{3}{8}$th inches diameter. There are also 56 stays attached at their upper extremities to the soffit of the bridge, and at their other ends well anchored to the rocks below. The superstructure is thus tied down as well as suspended, and all undulations directly resisted.

"The bridge was commenced in September 1852, and opened for traffic in March 1855. The total cost was £80,000."

The use of two chains of different versed sines is certainly a defect in this design.

There are several other suspension bridges in the United States of great span, *e.g.*, Cincinnati. 1057 feet; Brooklyn 1600 feet.

§ 81. *Saltash, Victoria, and Coblentz Bridges. Fink Truss.* Salt-
—Fig. 131 shows one span of Saltash Bridge erected by

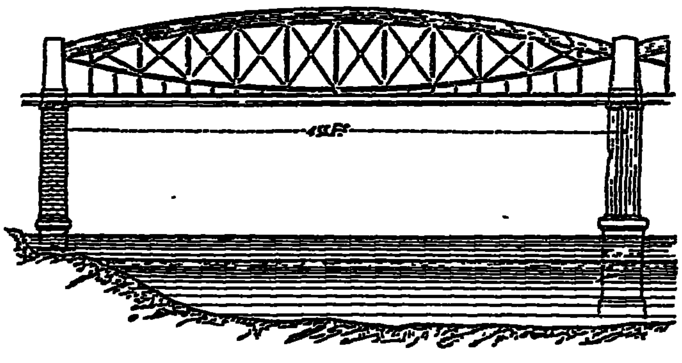

FIG. 131.—Span of Saltash Bridge.

Brunel. The span is 455 feet. The pier is a column or circular pillar of solid masonry, 35 feet diameter and 96 feet high from the rock foundation to above high-

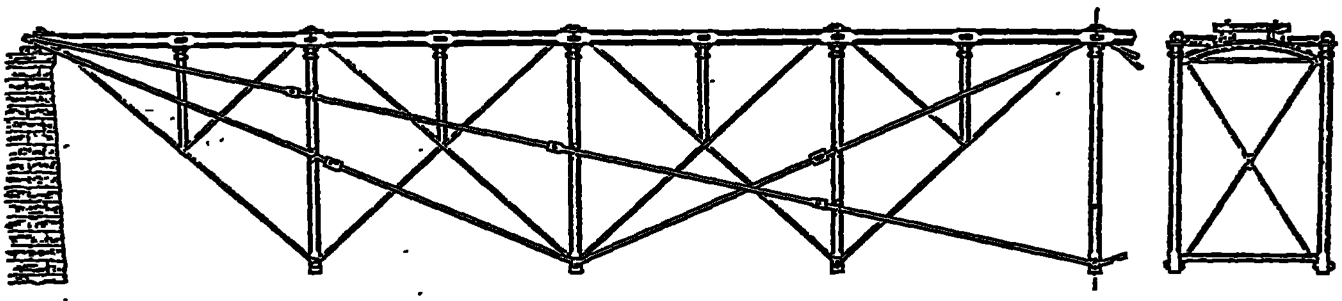

FIG. 132.—Fink Truss.

water mark. Upon this are placed four octagonal columns of cast-iron, 10 feet diameter, carried up to the level of the roadway, which is 100 feet above high-water mark.

Victoria Bridge Montreal. The Victoria Bridge over the St Lawrence at Montreal is a tubular bridge of great length (7000 feet), chiefly remarkable for its ice breakers, shown in fig. 93.

Fig. 132 shows some details of a Fink truss as used in America. The mode of computing the stresses on this truss has already been explained in § 59. All the struts are cast-iron tubes.

Fig. 133 shows one of the wrought iron arches of a Cobl
bridge over the Rhine at Coblentz. The bridge consists of three spans of about 315 feet each.

§ 82. *St Louis and Illinois Bridge.*—The St Louis and St Louis Bridge.

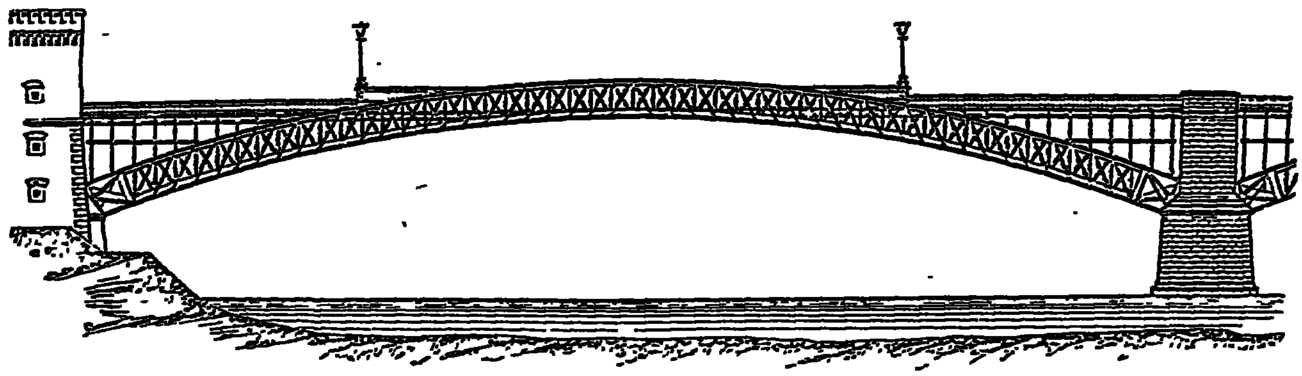

FIG. 133.—Arch of Bridge at Coblentz.

Illinois bridge over the Mississippi (fig. 5, Plate XVIII.) is the finest example of a metal arch yet erected. It is described as follows by Sir Charles A. Hartley who visited it in 1873:—

"The Mississippi at St Louis is confined to a single channel 1600 feet wide and 8 feet deep at extreme low water by an embankment or levee on the Illinois side, which is carried up to the level of extreme high water, at which time the width is augmented to 2200 feet. Both shores are revetted below the low water, some with rubble stones, and protected by the wharf pavements above that line. The extreme range between high and low water is 41 feet. Owing to the narrow gorge through which the whole volume of the Mississippi flows the variations in the bed of the river are very great. Captain James B. Eads, M. Inst. C.E., the distinguished engineer who designed the bridge and superintended its construction, informed the author that a rise of 13 feet less than high-water mark caused a scour of 18 feet, and that in the freshet of 1870 the scour reached a depth of 51 feet below low-water mark alongside the east pier. These facts induced him to believe it possible that the scour, at times of extraordinary high flood, might extend even to the rock itself. He therefore determined to establish the piers and abutments on the rock; and this was done by means of caissons provided with air chambers and locks at depths for the east pier and east abutment reaching 136 feet below high-water mark, or 110 feet from the surface of the water where the foundation work was actually performed. This feat, which was satisfactorily executed in 1870–71, is quite unprecedented in the annals of engineering.

The piers and abutments are composed of coursed rubble masonry up to low-water mark. Above this level they are faced

with grey granite from the State of Maine, which cost £10 per cubic yard *in situ*. The interior of the work is of magnesian limestone. The massive appearance of the granite rock facing is very striking.

The contract prices, and the total quantities of the steel and iron work required for the bridge, are as follows :—

2,500	tons of steel, at £60 per ton	} of 2000 lbs.	
500	,, wrought iron, at £40 per ton...		
1,000	,, rolled iron, at £28 per ton......		
200	,, cast-iron at £16 per ton............	of 2240 lbs.	

The bridge has three spans, each formed with ribbed arches made of cast steel, a novelty in bridge building. The centre span is 520 feet and the side ones 502 feet in the clear.

The rise of the centre arch is 47½ feet, that of the side ones 46 feet each. These are by far the largest arched spans in the world, and under the able direction of Colonel Read, Captain Eads's chief assistant, they are now being rapidly erected gradually from each pier and abutment without the aid of centering. Each span is composed of four double ribs of steel (well braced together at their relative distances from each other), and the tubes forming them are jointed butt to butt. They are clasped together by wrought iron couplings (which proved to be much better than steel), furnished with parallel grooves corresponding with similar grooves in the tubes. Steel pins, varying from 4½ inches to 7 inches in diameter, pass through the centre of the couplings and the ends of the tubes at every joint. The vertical bracing between the upper and the lower tubular ribs, which are 12 feet apart from centre to centre, convert the two members into a single arch.

At the time of the author's visit two of the openings were already spanned by the steel tubes, which are all 18 inches in diameter, and 12 feet to 13 feet long, but of thicknesses varying from 1¼ inches to 2¼ inches.

The arches are to carry a double railroad track, and above the track a roadway 54 feet wide for carriages and foot passengers."

The bridge was opened, subsequently to Sir C. Hartley's visit, on the 4th July 1874.

§ 83. *Projected Bridges.*—The Tay Bridge is a railway bridge in course of construction (1876), to form a connection between the town of Dundee and the North British Railway system in Fife, and crosses the Firth of Tay about a mile and a half to the west of Dundee. The length of the bridge exceeds two miles. It will therefore be the longest iron bridge in the world. The following description has been furnished by Mr A. D. Stewart, who assisted the chief engineer, Mr T. Bouch, in the design of the bridge :—

Curves.—Commencing at the south shore, the bridge for the first five spans is on a curve of a quarter of a mile radius. It is then straight for a distance of a mile and a half. At the north shore, between high and low water mark, it describes a curve of a quarter of a mile radius, forming nearly a quarter of a circle towards the town of Dundee.

Gradients.—The level of the rails at the south end of the bridge is 78 feet above high water. The gradient descends 1 in 100 for the first three spans; it is level for the next two spans; it then ascends 1 to 353 towards the centre of the bridge. Over the navigable part of the river it is level, and the rails are 92 feet above high water, leaving 88 feet for the passage of shipping above high water of spring tides. From this the gradient falls 1 in 73½ to the end of the bridge.

Spans.—The portion of the bridge at present being executed extends to 3120 yards. It is intended to add an opening of 120 feet and a number of 27 feet spans at the north end. The magnitude of the several spans in order, commencing at the Fife shore, is as follows:—3 spans of 60 feet, 2 of 80 feet, 10 of 120 feet, 12 of 136 feet, 13 of 230 feet, 1 of 150 feet, 11 of 120 feet, 25 of 60 feet, 1 of 155 feet, and 6 of 27 feet—the total number of spans being thus 84.

whole material above the rock was thus excavated, the working chamber and shaft of the caisson were filled with concrete, put in in a liquid state, and when this solidified the building upwards of the pier was continued. A difficulty arose in keeping the cylinders vertical during the sinking. This was overcome by combining them into a single caisson. Between the fourteenth and fifteenth pier the rock disappears. At the sites of the next six piers the bed consists of a layer of hard material resting on silt. It is proposed to pile these piers from an outside staging within an oval-shaped wrought iron caisson. After the piles are driven, their heads are to be surrounded with concrete, the water is then to be pumped out of the caisson, and brickwork to be built up to the level of about 5 feet above high water. The upper portions of these, and of all the piers to the north of them, are to consist of cast-iron columns braced together.

From the twenty-second pier northwards the bed of the river consists of sand, with occasional layers of coarse gravel and boulders. It was, however, necessary to modify the designs for the piers, and the method of founding and building them, according to the load each had to carry.

For the 120 and 136 feet spans there are eighteen piers. For each pier two wrought iron caissons are prepared, partly cylindrical and partly conical in shape, and having a base of 15 feet. These are built on the fore-shore, and lined with brickwork; they are then floated out by means of pontoons having hydraulic machinery for lowering: when they have been sunk in their proper place until they take a bearing in the sand, the pontoons are removed, and by means of sand-pumps the material from the interior is removed and they sink by their own weight. During the operation of sinking, rings of wrought iron and brickwork are added to the top of the caisson, and stones are laid round the outside to fill the void caused by the scour and pumping. When a sufficient depth has been obtained the pumps are removed, and the interior is filled with liquid concrete; and when this has solidified, the brickwork is continued to above high water.

For the 230 feet spans, large wrought iron caissons of a cylindrical form, 31 feet in diameter, are erected on the fore-shore, one for each pier, and lined with brickwork to the height which it is intended to sink them in the sand. The upper and temporary portion of the caisson, of the same diameter as the under, but with no lining of brickwork, is placed on the top of the lower part and bolted securely to it. The compound caisson is floated out and sunk, as above described, by means of sand-pumps, and the permanent portion of the caisson is filled with concrete. The temporary portion is then unbolted by divers, and removed for further use. From the surface of the ground to above low water, the pier consists of a brick oval-shaped hollow cylinder, which is built on the fore-shore on girders; and when it has thoroughly set, it is also floated out and lowered on the concrete foundation. The interior of this brick pier is then filled with concrete, and the building of the brickwork is continued to above high water as tidal work.

For the 60 feet spans towards the north end of the bridge, the piers consist of three braced cast-iron columns placed in a row across the bridge, the western column having a rake or batter of 1 in 3. Every fourth pier is double. Some of these were sunk as screw piles, others were founded in 6 feet cylinders, previously sunk by sand-pumps, and filled with concrete.

Superstructure.—The superstructure consists wholly of wrought iron girders. With the exception of two spans which have girders of the bowstring form, they have the top and bottom members straight and parallel. The bracing is of the double lattice form, crossing nearly at right angles, and from the point of intersection a vertical support is carried to the member on which the cross-girder or beam rests. The girders for the 230 feet spans, and the bowstring girders, have wrought iron cross girders resting on, and rivetted to, the lower member on which the roadway is placed. All the others have timber cross-beams resting on and rivetted to the top flange, and the roadway is above these girders. They are sent to the Tay built in convenient pieces for shipment, and rivetted together on jetties prepared near the shore. They are then floated out and raised to their places by machinery suited to their respective weights. They are generally continuous in groups of four consecutive spans. In order to make continuity perfect, the further end of each girder is raised through a certain calculated height before rivetting it to the next.

Montreal papers state that a bridge 15,500 feet in length is about to be constructed over the St Lawrence at Montreal, from the designs of Mr Legge. It will have one span of between 500 and 600 feet, and 60 smaller spans, with a height of 130 feet above the water at high tide. The estimated cost is £800,000.

§ 84. *Statistics.*—Table XVI., from the 8th edition, gives some statistical information as to the weight, cost, and dimensions of some of the principal cast-iron bridges.

Tables XVII. and XVIII. give various details regarding some important bridges of various construction and dimensions.

TABLE XVI.—*Cast-Iron Bridges.*

NAME OF BRIDGE.	No. of Openings.	Span.	Rise.	Total weight of Ironwork.	Cost.	Date of Completion.
		Ft. In.	Ft. In.	Tons		
Coalbrookdale	1	100 6	50 0	378½	...	1779
Buildwas	1	130 0	{30 0 / 14 0}	174	£6,034	1796
Sunderland Bridge	1	236 0	34 0	260	27,000	1796
Laason Bridge	1	43 0	...	...	...	1794
Staines Bridge	1	180 0	16 0	...	...	1802
Pont du Louvre ...	9	57 0	10 8	263	...	1803
Pont d'Austerlitz...	5	106 0	10 8	...	...	1806
St Denis	1	39 5	3 3	...	...	1808
Bristol Bridge	1	100 0	15 0	150	4,000	...
Craigellachie Bridge	1	150 0	20 0	...	8,200	...
Witham Bridge.....	1	86 0	5 0	...	...	...
Vauxhall Bridge ..	9	78 0	29 0	...	300,000	1816
Southwark Bridge	3 {1 / 2}	240 0 / 210 0	24 0 / 21 0	5780	800,000	1819
Tewkesbury Bridge	1	170 0	17 0	...	...	...
Galton Bridge	1	180 0	18 0	...	...	...

TABLE XVII.—*Dimensions of Large Masonry Bridges.*

Flat Arches.	Span in feet.	Versine in feet.	Maximum Radius in feet.	Thickness. Of Crown in feet.	Thickness. Of Abutments at base.
Trezzo over Adda......	251·	...	134·	...	...
Dorlaston, Segmental	86·51	13·48	76·1	3·510	32·022
Trilport, Elliptical ...	80·38	27·69	...	4·462	19·
Nantes ,, ...	115·16	34·41	89·5	6·397	28·
Neuilly ,, ...	127·89	31·95	160·	5·315	35·
Waterloo ,, ...	120·	32·	112·5	4·5	40·
London Bridge ,, ...	152·	29·6	...	4·75	..
Alma (Béton) ,, ...	141·4	28·2	...	4·92	...
Grosvenor Bridge, Chester	200·	42·	143·	4·	...

TABLE XVIII.—*Dimensions and Cost of Large Bridges.*

Name of Bridge.	Maximum. Approx. Hght.	Maximum. Span.	Length.	Reputed Cost. Total Amount.	Reputed Cost. Per Foot run.	Nature of Bridge.
	Ft.	Ft.	Ft.	£	£	
Britannia ...	125	460	1,511	601,865	398	Two lines Railway—tubular.
Charing-cross	50	154	1,365	180,000	131	Four lines Railway—double Warren.
Boyne	90	264	550	140,000	254 ?	Four lines Railway—lattice.
Crumlin	200	150	1,800	39,000	21	Two lines Railway—lattice on open-work piers.
Craigellachie	20	200	413	12,200	29·5	One line Railway—lattice, and plate girder.
Grand river (Mauritius)	130	12	620	30,000	50	One line Railway—plate girder.
Deepdale......	150?	60	740	20,266	27	Two lines Railway—lattice on open-work piers.
Westminster	20	120	1,160	235,000	202	Road—cast and wrought iron arch, 83 feet wide.
Fribourg......	167	...	808	24,000	29	Wire-rope Suspension Bridge—road only.
Niagara	245	808*	800	80,000	100	Wire-rope Suspension Bridge—road and railway.
Landore	75	110	1,760	28,720	16·3	Wooden Trusses.

* Platform.

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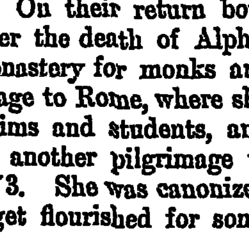
(F. J.)

BRIDGET, St, one of the patron saints of Ireland, who lived during the 6th century, was a daughter of one of the princes of Ulster, and took the monastic vow at a very early age. Her cell, the first in Ireland, was erected under a large oak tree, whence the place was called Kil-dara, the cell of the oak. The city of Kildare is supposed to derive its name from St Bridget's cell. A whole collection of miraculous stories have clustered round her name, and her reputation was not confined to Ireland, for St Bride was a favourite saint in England and in Scotland.

BRIDGET, St, of Sweden, was born about the year 1302. She was descended from a family of royal blood, and at the age of sixteen was married to Alpho, prince of Nericia. The husband and wife were equally devoted to works of piety, and undertook together a pilgrimage to the shrine of St Jago de Compostella. On their return both embraced the monastic life, and after the death of Alpho, his wife founded a new kind of monastery for monks and nuns. She then went on a pilgrimage to Rome, where she founded a house for Swedish pilgrims and students, and composed her *Revelationes*. After another pilgrimage to Jerusalem, she died at Rome in 1373. She was canonized in 1391. The order of St Bridget flourished for some time; they had one house in Britain.

BRIDGETOWN. See Barbados, vol. iii. p. 359.

BRIDGEWATER, or Bridgwater, a municipal (once a parliamentary) borough and seaport in Somerset, on the Great Western Railway, 29 miles S.S.W. of Bristol. It is pleasantly situated in a level and well-wooded country, having on the east the Mendip range and on the west the Quantock hills. The town, which is well built, lies along both sides of the River Parret, here crossed by a handsome iron bridge. It has an ancient Gothic church with a spire 174 feet in height, a town-hall, court-rooms, a jail, a market-place, an infirmary, a free grammar school, and some alms-houses. The river, which is subject to a bore, often two fathoms deep at the mouth, is navigable for vessels of 700 tons up to the town. The customs duties in 1874 were £7227. The chief imports are grain, coals, wine, hemp, tallow, and timber; the exports, agricultural produce, earthenware, cement, plaster of Paris, and bath-bricks, which last constitute the staple trade of the town. The value of the imports in 1874 was £118,509, and of the exports £5011. The town returned two members to parliament till 1870, when the borough was disfranchised. Population in 1871, 10,259. Bridgewater is said to derive its name, which appears in earlier times as Brugge Walter, from a certain Walter de Douay, to whom the manor was presented at the Conquest. In the reign of Henry II. a splendid castle was built and a harbour constructed by William de Briwere; and in 1230 a Grey-Friars' monastery was founded by his son. The castle was taken by the Royalists in 1643, and was almost completely demolished after its capture by the Parliamentary forces in 1645. Admiral Blake was a native of Bridgewater.



Arms of Bridgewater.

difficulties that retarded the accomplishment of his project, together with the pecuniary restrictions he imposed on himself in order to supply the necessary capital, affords an instructive example of that energy and self-denial on which the success of great undertakings so much depends. Though a steady supporter of Mr Pitt's administration, he never took any prominent part in politics. On his death, March 8, 1803, the ducal title became extinct.

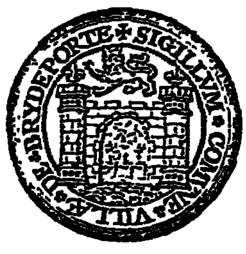
BRIDGEWATER, the Rev. Francis Henry, eighth earl of, was born in 1758 and died on the 11th February 1829. He is best known as the originator of the *Bridgewater Treatises*. By his will he devised the sum of £8000, at the disposal of the president of the Royal Society, to be paid to the author or authors selected by the president to write and publish 1000 copies of a treatise "On the Power, Wisdom, and Goodness of God, as manifested in the Creation." Mr Davies Gilbert, who then filled the office, selected eight persons, each to undertake a branch of this subject, and each to receive £1000 as his reward, together with any benefit that might accrue from the sale of his work, according to the will of the testator.

The treatises were published as follows:—1. *The Adaptation of External Nature to the Moral and Intellectual Condition of Man*, by the Rev. Thomas Chalmers, D.D. 2. *The Adaptation of External Nature to the Physical Condition of Man*, by John Kidd, M.D. 3. *Astronomy and General Physics considered with reference to Natural Theology*, by the Rev. William Whewell, D.D. 4. *The Hand, its Mechanism and Vital Endowments as evincing Design*, by Sir Charles Bell. 5. *Animal and Vegetable Physiology considered with reference to Natural Theology*, by Peter Mark Roget. 6. *Geology and Mineralogy considered with reference to Natural Theology*, by the Rev. William Buckland, D.D. 7. *The Habits and Instincts of Animals with reference to Natural Theology*, by the Rev. William Kirby. 8. *Chemistry, Meteorology, and the Function of Digestion, considered with reference to Natural Theology*, by William Prout, M.D. The works are of unequal merit; several of them took a high rank in apologetic literature.

BRIDLINGTON, Brellington, or Burlington, a market-town of England, in the East Riding of Yorkshire, on the North-Eastern Railway, 23 miles from Scarborough. It lies about a mile from the coast on a gentle acclivity. The streets are narrow and the houses irregularly built. A large chamber over the old priory gateway (of the time of Richard II.) is used as a town-hall. The town has also a corn exchange, a temperance hall, a mechanics' institute, and two subscription libraries. The parish church of St Mary's preserves a considerable part of the Augustinian priory which was erected in the 12th century, by Walter de Gaunt, a relative of the Conqueror, and continued to flourish till 1537, when its last prior was executed for taking part in the "Pilgrimage of Grace." On the coast is situated the pleasant watering-place of Bridlington Quay, which has recently increased in reputation. The harbour is enclosed by two stone piers, and there is good anchorage in the bay. The beach consists of a fine firm sand, and is bordered by a parade with ornamental gardens. Besides hot and cold baths, there is a chalybeate spring esteemed for its medicinal properties; and the town is supplied with drinking-water from an intermittent fountain discovered below high water mark in 1811. The most important public building is the Victoria Rooms, which comprise a ball-room, a reading-room, a news-room, &c. The united population of *Bridlington and Bridlington Quay*, which in 1851 was 2432, amounted in 1871 to 6203. Bridlington was placed by Henry I. under the civil jurisdiction of the priors, and by John was allowed to hold a market and an annual fair. In 1643 the town was cannonaded by Admiral Batten, on account of the presence of Queen Henrietta, who had landed with a supply of arms. Sir George Ripley and John de Bridlington were connected with the priory; Kent the landscape-gardener was a native of the town; and his patron, Robert Boyle, bore the title

of earl of Burlington, from which the name of Burlington House in London is derived.

BRIDPORT, a parliamentary and municipal borough and market-town of England, in the county of Dorset, 18 miles by rail N.W. from Dorchester between two branches of the River Brit, from which it takes its name. The main part of the town is about a mile from the sea, with which it is connected by a single winding street, terminating in a quay surrounded by a fishing village. The principal buildings comprise a town-hall, a market-house, a jail, a custom-house, a mechanics' institute with reading and lecture rooms; there are also a school of art, alms-houses, and several charities. The parish church of St Mary, a cruciform edifice in the Perpendicular style, was restored in 1865. The harbour, which had become choked with sand, was rendered available and secure for vessels of 250 tons by extensive improvements undertaken in 1742 and 1823. The total value of the imports, which consist mainly of timber, coal, and flax, was in 1874 £89,616; and the exports amounted to £18,021. Its principal articles of manufacture have long been sail-cloth, cordage, linen, and fishing-nets. Bridport formerly returned two members to parliament, but since 1868 it returns only one. The population was 7670 in 1871. Though a place of considerable antiquity, it has very little historical importance. Its mint is mentioned in *Domesday Book*. In the reign of Henry VIII. the town and district had a monopoly of the supply of cordage for the Royal Navy.



Arms of Bridport.

BRIEG, the capital of a circle in the Prussian province of Silesia and government of Breslau, is situated on the left bank of the Oder, and on the Breslau and Oppeln Railway, 27 miles S.E. of the former town. It is well built, and has a castle (the residence of the old Piastic counts of Brieg), a lunatic asylum, a gymnasium with a good library, and several churches and hospitals. Its fortifications were destroyed by the French in 1807, and are now replaced by beautiful promenades. Brieg carries on a considerable trade, its chief manufactures being linen, cotton, and woollen goods, porcelain and machinery, hats, pasteboard, and cigars. Important cattle-markets are held there. Brieg, or, as it is called in early documents, *Civitas Altæ Ripæ*, obtained municipal rights in 1250 from Duke Henry III. of Breslau, and was fortified in 1297; its name is derived from the Polish *Brzeg* (shore). In the 14th century it became the seat of a line of counts, by one of whom the castle was built in 1341. Burned by the Hussites in 1428, the town was soon afterwards rebuilt, and in 1595 it was again fortified by Duke Joachim Frederick. In the Thirty Years' War it suffered greatly; in that of the Austrian succession it was heavily bombarded by the Prussian forces; and in 1806 it was captured by the French. Population in 1871, 15,372.

BRIEL, BRIELLE, or BRIL, a fortified seaport town of Holland, in the province of South Holland, and capital of an arrondissement, stands on the north side of the island of Voorne, near the mouth of the Maese, 14 miles west of Rotterdam, in 51° 54′ 11″ N. lat. and 4° 9′ 51″ E. long. The town is well built and strongly fortified, and has an arsenal, military magazines, barracks, and a good harbour. The tower of St Catharine's church serves as a lighthouse. Briel is remarkable in history as having been the first place captured in the struggle that resulted in the independence of the Netherlands—a fact which is commemorated in the popular rhyme, *Den eerste van April verloor duc d'Albe syne Bril*, punning on the meaning of Bril, which is the Dutch for "spectacles." Admiral Van Tromp was born in the town. The inhabitants, who are principally engaged as fishermen and pilots, numbered 4058 in 1869.

BRIGADE, a tactical body, composed of two or more regiments of cavalry or infantry, under the command of a general officer of the lowest grade. The term *brigade* is also applied to from four to eight batteries of artillery working together, and to the small detachments (eight or nine men) of engineers employed in excavating saps in siege operations. Two or more brigades constitute a division, two or more divisions a corps d'armée, two or more corps d'armée an army.

BRIGADE-MAJOR, a third-class staff officer, appointed by the brigadier to assist him in the management of his brigade.

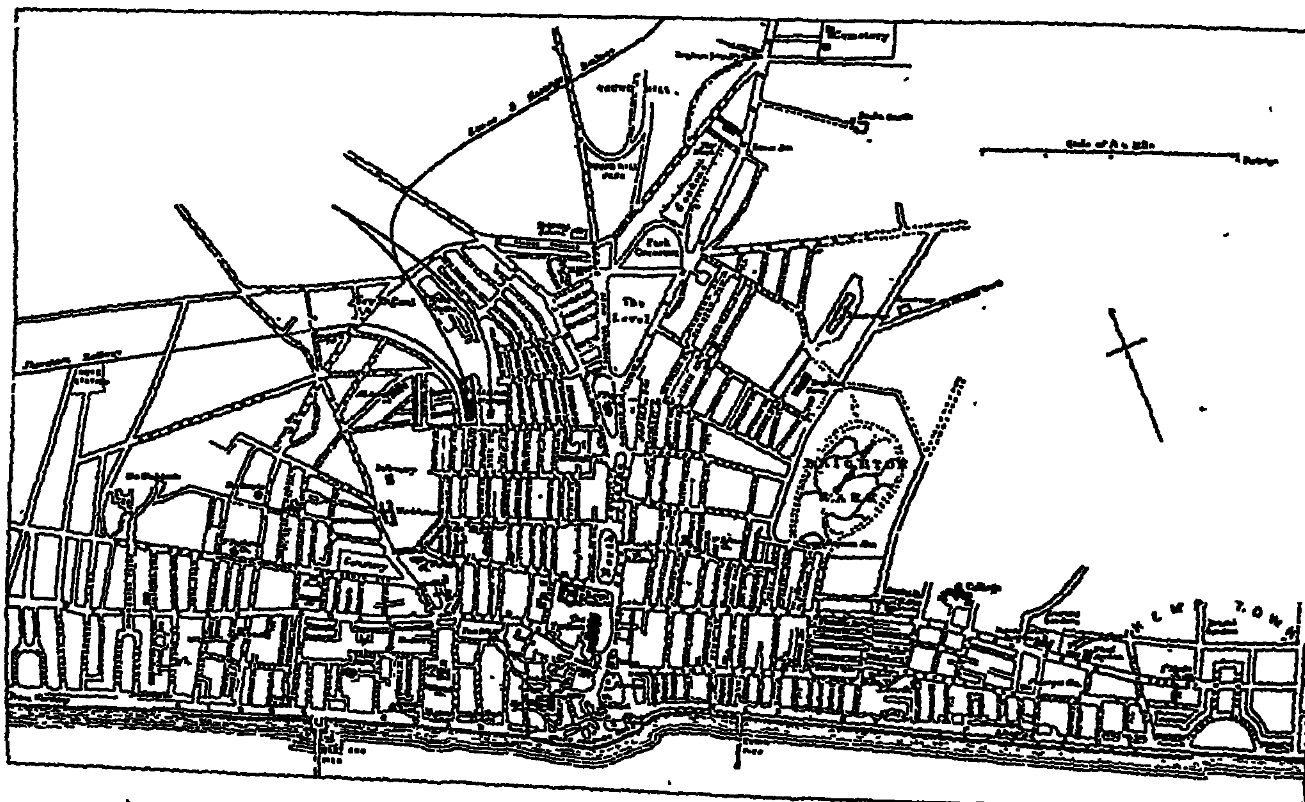
BRIGADIER, a general officer of the lowest grade, next in rank above a colonel, who is intrusted with the command of a brigade.

BRIGGS, HENRY, one of the greatest mathematicians of the 16th century, was born in 1556 at Warley Wood near Halifax, in Yorkshire. He studied at St John's College, Cambridge, graduated in 1581, and obtained a fellowship in 1588. In 1592 he was made reader of the physical lecture founded by Dr Linacre, and in 1596 first professor of geometry in Gresham House (afterwards College), London. In his lectures at Gresham House he proposed the alteration of the scale of logarithms from the hyperbolic form which Napier had given them, to that in which unity is assumed as the logarithm of the ratio of ten to one; and soon afterwards he wrote to the inventor on the subject. In 1616 he paid a visit to Napier at Edinburgh in order to discuss the suggested change; and next year he repeated his visit for a similar purpose. During these conferences the alteration proposed by Briggs was agreed upon; and on his return from his second visit to Edinburgh in 1617 he accordingly published the first chiliad of his logarithms. In 1619 he was appointed Savilian professor of geometry at Oxford, and resigned his professorship of Gresham College on the 25th of July 1620. Soon after his settlement at Oxford he was incorporated master of arts in that university, where he continued a laborious and studious life, employed partly in discharging the duties of his office, and partly in the computation of logarithms and in other useful works. In 1622 he published a small tract on the *North-West Passage to the South Seas, through the Continent of Virginia and Hudson's Bay*; and in 1624 he printed at London his *Arithmetica Logarithmica*, in folio, a work containing the logarithms of thirty thousand natural numbers to fourteen places of figures besides the index. He also completed a table of logarithmic sines and tangents for the hundredth part of every degree to fourteen places of figures besides the index, with a table of natural sines to fifteen places, and the tangents and secants for the same to ten places; all of which were printed at Gouda in 1631 and published in 1633 under the title of *Trigonometria Britannica*. Briggs died on the 26th of January 1630 in the 74th year of his age. Dr Smith, in his *Lives of the Gresham Professors*, characterizes him as a man of great probity, a contemner of riches, and contented with his own station, preferring a studious retirement to all the splendid circumstances of life.

His works are—1. *A Table to find the Height of the Pole, the Magnetical Declination being given*, London, 1602, 4to. 2. "Tables for the Improvement of Navigation," printed in the second edition of Edward Wright's treatise entitled *Certain Errors in Navigation detected and corrected*, London, 1610, 4to. 3. *A Description of an Instrumental Table to find the part proportional, devised by Mr Edward Wright*, London, 1616 and 1618, 12mo. 4. *Logarithmorum Chilias prima*, London, 1617, 8vo. 5. *Lucubrationes et Annotationes in opera posthuma J. Neperi*, Edin., 1619, 4to. 6. *Euclidis Ele-*

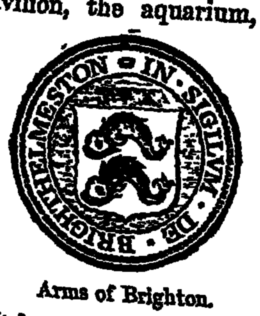
mentorum VI. libri priores, London, 1620, folio. 7. *A Treatise on the North-West Passage to the South Sea*, London, 1622, 4to, reprinted in Purchas's *Pilgrims*, vol. iii. p. 852. 8. *Arithmetica Logarithmica*, London, 1624, folio. 9. *Trigonometria Britannica*, Goudæ, 1663, folio. 10. Two *Letters* to Archbishop Usher. 11. *Mathematica ab Antiquis minus cognita*. Some other works, as his *Commentaries on the Geometry of Peter Ramus*, and *Remarks on the Treatise of Longomontanus respecting the Quadrature of the Circle*, have not been published.

BRIGHTON, a parliamentary borough, and one of the most fashionable watering-places of England, is situated on the coast of Sussex between Beachy Head and Selsea Bill, in 50° 50′ N. lat. and 0° 8′ W. long. By railway it is 50 miles from London and 28 from Chichester. Its sea-frontage of handsome mansions and hotels extends upwards of three miles from Kemp Town in the east to what was formerly the suburban village of Cliftonville in the parish of Hove; while its depth inland at the centre is rather more than a mile. In general appearance the style of the town strikingly resembles that of London; and many of its streets and squares seem as if they had been transported as they stand from the "West End." As far, indeed, as its character is not affected by its natural situation, it is nothing more or less than a vigorous offshoot supported by the sap of the greater city, a fact which is popularly recognized by the designation of London-super-Mare. During the present century its growth has been rapid and continuous, about four hundred new houses being often built in the space of a year. Its streets and squares already amount to four hundred; but in comparison with this extent the number of its really remarkable buildings is rather small, and nearly all of them are of modern date. Among its twenty Episcopalian and between thirty and forty Nonconformist churches two only need be specially mentioned,—the parish church of St Nicholas, which was built



Plan of Brighton.

in the reign of Henry VII., and is probably one of the oldest buildings in the town, and Trinity chapel, in Ship Street, memorable as the scene of the labours of Frederick William Robertson. The most important of the secular edifices are the town-hall, the market, the pavilion, the aquarium, the theatre, the proprietary college, the Sussex county hospital, the new workhouse, the infirmary, the blind asylum, and the female orphan asylum. The pavilion, with its strange assemblage of domes and minarets, was built in 1784–7 as a residence for the Prince of Wales (afterwards George IV.), and about 1818 it was refashioned by Nash into a grotesque imitation of Chinese architecture. It has a frontage to the east of 300 feet, and occupies, with its gardens, about 11½ acres. In 1850 it was purchased by the town for £53,000, and its spacious rooms, greatly altered from time to time, are now appropriated to a variety of uses,—one serving as a museum, another as an assembly-room, others as picture-galleries. The pavilion dome, formerly the royal stables, is now converted into a magnificent hall for high-class musical performances; it is lighted by a glazed dome, with



Arms of Brighton.

a diameter only 20 feet less than that of the dome of St Paul's of London. The county hospital was built in 1828 by Sir Charles Barry, at a cost of £10,000, and has since been largely extended. It is "open to the sick and lame poor of every country and nation." There are a large number of minor benevolent establishments in the town, and so various are its educational institutions that it has been called the city of schools. Among the bathing establishments the most remarkable are Brill's and the New Turkish Baths; the former includes extensive swimming baths for both sexes.

The tendency of the currents in the channel opposite Brighton is to drive the shingle eastward, and within the memory of man large portions of the coast have thus been destroyed. To prevent this erosion the whole sea-frontage of the town at the east end is protected by a great sea-wall, which was built between 1827 and 1838. It is a mile long, 60 feet high, and 23 feet thick at the base, and cost £100,000. The beach is further ribbed from north to south by various "groynes," or jetties, one of which, constructed of concrete in 1867, at a cost of £5000, stretches about 250 feet into the sea. There are two piers which serve as promenades. The first, an elegant chain fabric commenced by Sir S. Brown, R.N., in 1822, was

opened to the public in the following year. It is 1136 feet in length and 15 feet in width, the four cast-iron columns on which it is suspended being supported by stone buttresses based on oaken piles driven into the solid chalk. The cost was £30,000, and in 1836 an additional expenditure was necessary to repair the damage inflicted by a great storm in November of that year, which was within a little of destroying the structure altogether. A new pier further to the west was opened in 1866. Its total length is 1115 feet, and it affords accommodation for 2000 people. The town is well supplied with water by the corporation waterworks, and by an artesian well, 1285 feet deep, at Warren Farm, the boring of which lasted from 1858 to 1862. The sewage is effectively removed by an intercepting sewer 5 miles in length, which discharges into the sea 2 miles east of the parish boundary. Since the opening of the Brighton railway in 1841 the town has developed wonderfully; but, with the exception of the railway works, no manufacturing establishment exists, and no tall chimneys are seen. Owing to the absence of a natural harbour the commerce of the place is insignificant, but the mackerel and herring-fisheries are carried on by about 120 boats. The races, which are held in August to the north and north-east of the town, and the great volunteer reviews, which of late years have drawn many thousands to the neighbouring downs, add considerably to the local trade. The town is governed by a mayor, thirteen aldermen, and a council. It returns two members to parliament.

Brighton, originally Brighthelmstone, plainly derives its name from some Saxon Brighthelm, but who or what he was there seems no means of discovering. The present contracted form of the word came into general use only in the end of the 18th century, but it is sometimes found in the documents of the time of Charles II. At the time of the Conquest Brighton was a small fishing village, and the lordship of the manor was bestowed by the Conqueror on his nephew William de Warrenne, who received as rent from the fishermen 4000 herrings. In 1513 it was burnt by the French under Messire Pregent, whom the English chronicles call Prior John; and in 1545 it was again greatly damaged by Claude d'Annebalte, the admiral of Francis I. At that time it is represented as a quadrangular town of four or five streets. There were then no defences, but in 1558 a small circular fort was erected by Elizabeth. The town seems to have rapidly recovered its prosperity, for in 1579 it possessed 80 fishing-boats, with 400 fishermen and 10,000 nets. The whole Elizabethan town, however, has been destroyed by the sea, which in 1699 swept away 160 houses, and in 1703 and 1706 did almost as much damage. The modern reputation of Brighton is due to Dr Richard Russell, a native of Lewes, who resided there in 1750, and wrote a book on the advantages of sea-bathing, which led a number of people of high rank—among others the dukes of Cumberland and Marlborough—to place themselves under his direction. The Prince Regent followed, and the fortunes of Brighton were made. Bedford Square was commenced in 1810, and the building of Kemp Town took place between 1821 and 1830. A charter of incorporation was granted in 1854. In 1761 the population was only about 2000; in 1801 it had risen to 7339, by 1841 to 46,567, and by 1851 to 69,673. In 1861 there were 77,693 inhabitants in the municipal borough, and 87,317 within the parliamentary limits, the number of houses being respectively 12,727 and 13,983, while in 1871 the municipal borough had a population of 90,011, inhabiting 14,438 houses, and the parliamentary borough 103,758, with 16,284. See Lower's *History of Sussex*, 1870, and papers in the *Sussex Archæological Collections*.

BRIGHT'S DISEASE, a term in medicine applied to a class of diseases of the kidneys which have as their most prominent symptom the presence of albumen in the urine, and frequently also the co-existence of dropsy. These associated symptoms in connection with kidney disease were first described in 1827 by Dr Richard Bright. Since that period the subject has been investigated by many able physicians, and it is now well established that the symptoms above named, instead of being as was formerly supposed the result of one form of disease of the kidneys, may be dependent on various morbid conditions of those organs. Hence the term Bright's disease, which is retained in medical nomenclature in honour of Dr Bright, must be understood as having a generic application.

Two varieties of Bright's disease are described, the *acute* and the *chronic*,—the former representing the inflammatory and the latter the degenerative form of kidney disease.

Acute Bright's Disease (synonyms—*acute desquamative nephritis, acute albuminuria*, &c.) commonly arises from exposure to cold, from intemperance, or as a complication of certain acute diseases, such as erysipelas, diphtheria, and especially scarlet fever, of which it is one of the most frequent and serious consequences. In this form of the disease the kidneys become congested, their blood-vessels being gorged with blood, while the tubules are distended and obstructed by accumulated epithelium, as also by effused blood and the products of inflammation, all which are shed off and appear in the urine on microscopic examination as *casts* of the uriniferous tubes.

The symptoms to which the condition gives rise are usually of a severe character. Pain in the back, vomiting, and febrile disturbance commonly usher in the attack. Dropsy, varying in degree from slight puffiness of the face to an accumulation of fluid sufficient to distend the whole body, and to occasion serious embarrassment to respiration, is a very common accompaniment. The urine is reduced in quantity, is of dark, smoky, or bloody colour, and exhibits to chemical reaction the presence of a large amount of albumen, while, under the microscope, blood corpuscles and casts, as above mentioned, are found in abundance.

This state of acute inflammation may by its severity destroy life, or, short of this, may by continuance result in the establishment of one of the chronic forms of Bright's disease. On the other hand an arrest of the inflammatory action frequently occurs, and this is marked by the increased amount of the urine, and the gradual disappearance of its albumen and other abnormal constituents; as also by the subsidence of the dropsy and the rapid recovery of strength.

Of *chronic Bright's Disease* there are several forms, named according to the structural changes undergone by the kidneys. The most frequent of these is the *large white kidney*, which is the chronic form of the desquamative nephritis above mentioned.

Another form of chronic Bright's disease is the *waxy* or *amyloid kidney*, due to the degenerative change which affects first the blood-vessels and subsequently also the tubular structures of the organ. This condition is usually found associated with some chronic ailment of an exhausting character, such as disease of bones and other scrofulous affections, or with a generally enfeebled state of health. It is marked by the passage of large quantities of albuminous urine, and is frequently accompanied with general dropsy, as also with diarrhœa and consequent loss of strength. A third form of chronic Bright's disease is the *contracted kidney*, depending on the condition known as *cirrhosis*, in which the kidneys become reduced in bulk, but dense in texture, from an abnormal development of their connective tissue and relative atrophy of their true structure. This form of the disease, which is commonly, though not exclusively connected with a gouty constitution, is apt to escape detection in its earlier stages from the more obscure character of the symptoms, there being less albuminuria and less dropsy than in the other varieties. Its later progress, however, enables it to be readily recognized. Dimness of vision, due to a morbid condition of the retina, and also hypertrophy of the heart leading to fatal apoplexy, are frequent accompaniments of this form of the disease.

A fourth variety of chronic Bright's disease is described by authors on the subject, viz., *fatty degeneration of the kidneys*, occasionally occurring in old age and in connection with a similar degeneration of other organs.

The kidneys being among the most important excretory organs of the body, it follows that when their function is interrupted, as it is alike in acute and chronic Bright's disease, serious results are apt to arise from the retention in the economy of those effete matters which it is the office of the kidneys to eliminate. The blood being thus contaminated, and at the same time impoverished by the draining away of its albumen from the kidneys, is rendered unfit to carry on the processes of healthy nutrition; and, as a consequence, various secondary diseases are liable to be induced. Inflammatory affections within the chest are of frequent occurrence, but the most dangerous of all the complications of Bright's disease are the nervous symptoms which may arise at any stage, and which are ascribed to the effects of uræmic poisoning.

In the treatment of acute Bright's disease, good results are often obtained from local depletion, from warm baths, and from the careful employment of diuretics and purgatives. Chronic Bright's disease is much less amenable to treatment, but by efforts to maintain the strength and improve the quality of the blood by strong nourishment, and at the same time by guarding against the risks of complications, life may often be prolonged in comparative comfort, and even a certain measure of improvement be experienced.

See *Report on Medical Cases*, by Richard Bright, London, 1827; *On Granular Degeneration of the Kidneys*, by Robert Christison, M.D., Edinburgh, 1839; *Diseases of the Kidney*, by Dr G. Johnson, London, 1866; *Practical Treatise on Urinary and Renal Diseases*, by Wm. Roberts, M.D., London, 1865; *On the Pathology and Treatment of Albuminuria*, by W. H. Dickinson, M.D., London, 1868; *Practical Treatise on Bright's Diseases of the Kidneys*, by T. Grainger Stewart, M.D., Edin. 1871. (J. O. A.)

BRIGNOLES, the capital of an arrondissement in the department of Var, in France, is situated in a fertile and pleasant valley on the right bank of the Calami, 22 miles N.N.E. of Toulon. It is neat and well built, and has a magnificent fountain, a public library, a normal school, manufactures of silk thread and leather, and an active trade in wines, brandy, liqueurs, and excellent prunes—the last distinctively known as *prunes de Brignoles*. The prefecture has its offices in the palace of the counts of Provence, and the old house of the Templars is occupied by the theological seminary. Brignoles is a town of great antiquity. In 1291 it gave its name to a treaty between Alphonso III. of Aragon and the king of France. In ancient documents it is often mentioned as *Villa Puerorum*, from the fact that the children of the counts of Provence were generally born and brought up in the castle. In 1524 the town was taken and pillaged by Charles V., and in 1588 it met a similar fate at the hands of the Leaguers. Population of town in 1872, 4843.

BRIL, Paul, a Flemish painter, born at Antwerp in 1554. The success of his elder brother Matthew in the Vatican induced him to repair to Rome. On the death of Matthew, Paul, who far surpassed him as an artist, succeeded to his pensions and employments. He painted landscapes with a depth of chiaroscuro then little practised in Italy, and introduced into them figures well drawn and finely-coloured. Many of his pictures are extant in Italy. One of his best compositions is the martyrdom of St Clement, in the Sala Clementina of the Vatican. He died at Rome in 1626. (See Lanzi, *History of Painting*.)

BRINDISI, a fortified city and seaport of Italy, in the province of Otranto, is situated at the head of a bay of the Adriatic in 40° 39′ 27″ N. lat. and 17° 28′ 44″ E. long. The streets are for the most part narrow and crooked, and the town in general is in a somewhat ruinous condition. Since the restoration of its maritime importance, which is mainly due to the fact that it forms the great transit station in the overland route to Asia by the Mont Cenis Railway and the Suez Canal, some improvement has taken place, and it bids fair to become one of the most flourishing cities in the country. The progress, however, has hitherto been comparatively slow, and the only extensive addition which has been effected is a new street leading from the railway station to the harbour. A cathedral in rather a dilapidated state, a citadel with huge round towers (founded by Frederick II. and completed by Charles V.), and a seminary (containing a library bequeathed to the town by archbishop Leo), are the only public buildings worthy of notice. The ruins of the circular church of St Giovanni, which was destroyed by earthquake, are not without interest; an ancient building of uncertain date is popularly regarded as the house where Virgil died; and there is a remarkable column supposed by some to have marked the termination of the Appian Way, but more probably belonging to an ancient temple. There are ten public schools in the town. The trade was represented in 1873 by imports to the value of £344,000, and exports to £325,000. The former consist mainly of raw silk, wheat and flour, coals, manufactured cottons, and petroleum; and the latter of manufactured coral, corn, dried fruits, and olive oil. The number of vessels that arrived at the port in 1873 was 709, of which 422 were steamships. The harbour consists of an outer and an inner portion, and the inner is divided into two basins, extending right and left. The outer port is about 6400 feet long by 3200 wide, the western arm of the inner portion 4800 by 800, and the eastern arm 3520 by 640. An extensive system of dredging has been in operation since 1866, and long lines of quays are being gradually constructed. Graving-docks are also in course of construction; and a lagoon, called *Fiume Piccolo*, close to the outer harbour, which has been a constant source of malaria, is being filled up. The population of the town, which was only 8000 in 1861, had increased to 13,755 in 1871.

Brindisi, *Brundisium*, or Βρεντέσιον, was originally, it would appear, a city of the Sallentines, from whom it was captured by the Romans in 267 B.C. Colonized by its conquerors in 244 B.C., it soon rose into importance, and became their chief naval station in the Adriatic. Hannibal vainly attempted to surprise the city, which remained faithful to Rome through the darkest days of the Punic struggle. During the war between Julius Cæsar and Pompey the former endeavoured to shut up his rival's fleet in the inner harbour, by closing the entrance with wooden piles, which are frequently but erroneously supposed to have been the cause of the destruction of that part of the port. On the fall of the Western Empire Brundisium seems to have been outstripped by the neighbouring city of Hydruntum (Otranto). In the 10th century it was destroyed by the Saracens, but was rebuilt by Spathalupus the Byzantine governor, whose name still stands graven on the marble column above mentioned. After passing through various vicissitudes in common with the rest of Southern Italy, it fell into the hands of the Normans, and in the 11th century it was the scene of the chivalrous pageantry of Tancred's court. It was plundered in 1348 by Louis, king of Hungary, and in 1458 suffered severely from an earthquake. Some time before this last disaster a more serious injury had been inflicted by Prince Giovanni Antonio Orsini, who completely choked the entrance to the inner port by sinking a number of vessels laden with stone. The commercial importance of the city rapidly declined, and it was of no interest save to the classical scholar as the birthplace of Pacuvius, and from its association with the mirthful journey of Horace and the death of Virgil.

BRINDLEY, James, a celebrated engineer, was born at Thornsett, Derbyshire, in 1716. His parents were in very humble circumstances, and he received little or no education. At the age of seventeen he was apprenticed to a millwright near Macclesfield, and while in this employment manifested remarkable mechanical talent. Soon after completing his apprenticeship he set up in business for himself as a wheelwright, and quickly became famous for his ingenuity and skill in repairing all kinds of machinery. In 1752 he designed and set up an engine for draining some coal-pits at Clifton in Lancashire. Three years later he extended his reputation by completing the machinery for a silk-mill at Congleton. About 1754 Brindley became acquainted

with the duke of Bridgewater, and an arrangement was soon come to whereby he undertook to carry out that nobleman's scheme of inland navigation. The duke's primary object was the carriage of coal from his estate at Worsley to Manchester. The difficulties in the way were great, but all were surmounted by the genius of Brindley, whose crowning triumph was the carrying the new canal over the River Irwell at Barton, by means of an aqueduct elevated 39 feet above the water. The great success of this canal, the first of its kind in Great Britain, encouraged similar projects, and Brindley was soon engaged extending his first work to the Mersey. He then designed and nearly completed what he called the Grand Trunk Canal, connecting the Trent and Humber with the Mersey. The Staffordshire and Worcestershire Canal, the Oxford Canal, the Stockwith and Chesterfield Canal, were all planned and carried out by him. His excessive toil broke down his strength, and he died in 1772 at the early age of fifty-six. Brindley was a man of no education; he retained to the last a peculiar roughness of character and demeanour; but his innate power of thought more than compensated for his lack of training. It is told of him that when in any difficulty he used to retire to bed, and there remain intensely pondering his problem until the solution became clear to him. His mechanical ingenuity and fertility of resources were very remarkable; he undoubtedly possessed in the very highest degree the engineering faculty, though the kind of works to which he devoted himself has been cast into the shade by the later developments of steam traffic. Brindley was an enthusiast in his business and possessed with the idea of canals. His reported answer to the committee who asked him what was the use of navigable rivers,—"To feed canals," is characteristic, if not altogether authentic.

See Smiles, *Lives of the Engineers*, vol. i.; *Biographia Britannica.*

BRIOUDE, a town of France, in the department of Haute Loire, capital of an arrondissement, is situated on the left bank of the Allier, 39 miles N.W. of Puy. The town is ill-built, but has a fine old Gothic church (St Julien, of the 12th century, with curious mosaic ornamentation), a college, a public library, and beautiful fountains, which date from the 13th century. At Old Brioude, about three miles S.S.E., are the remains of a bridge over the Allier, which consisted of a single arch 60 feet high and 206 feet in span. (See article BRIDGES, p. 332.) This fell in 1822; and a new bridge of one arch, 182 feet in span, was built in 1845. Population in 1872, 4524.

Brioude, the ancient *Brivas*, was formerly a place of considerable importance. It was in turn besieged and captured by the Goths (532), the Burgundians, the Saracens (732), and the Normans. In 1181 the viscount of Polignac, who had sacked the town two years previously, made public apology in front of the church, and established a body of twenty-five knights to defend the relics of St Julian. For some time after 1361 the town was the headquarters of the lord of Castelnau, who was at the head of one of those bands of military adventurers which then devastated France. The knights (or canons, as they afterwards became) of St Julian bore the title of counts of Brioude, and for a long time opposed themselves to the civic liberties of the inhabitants.

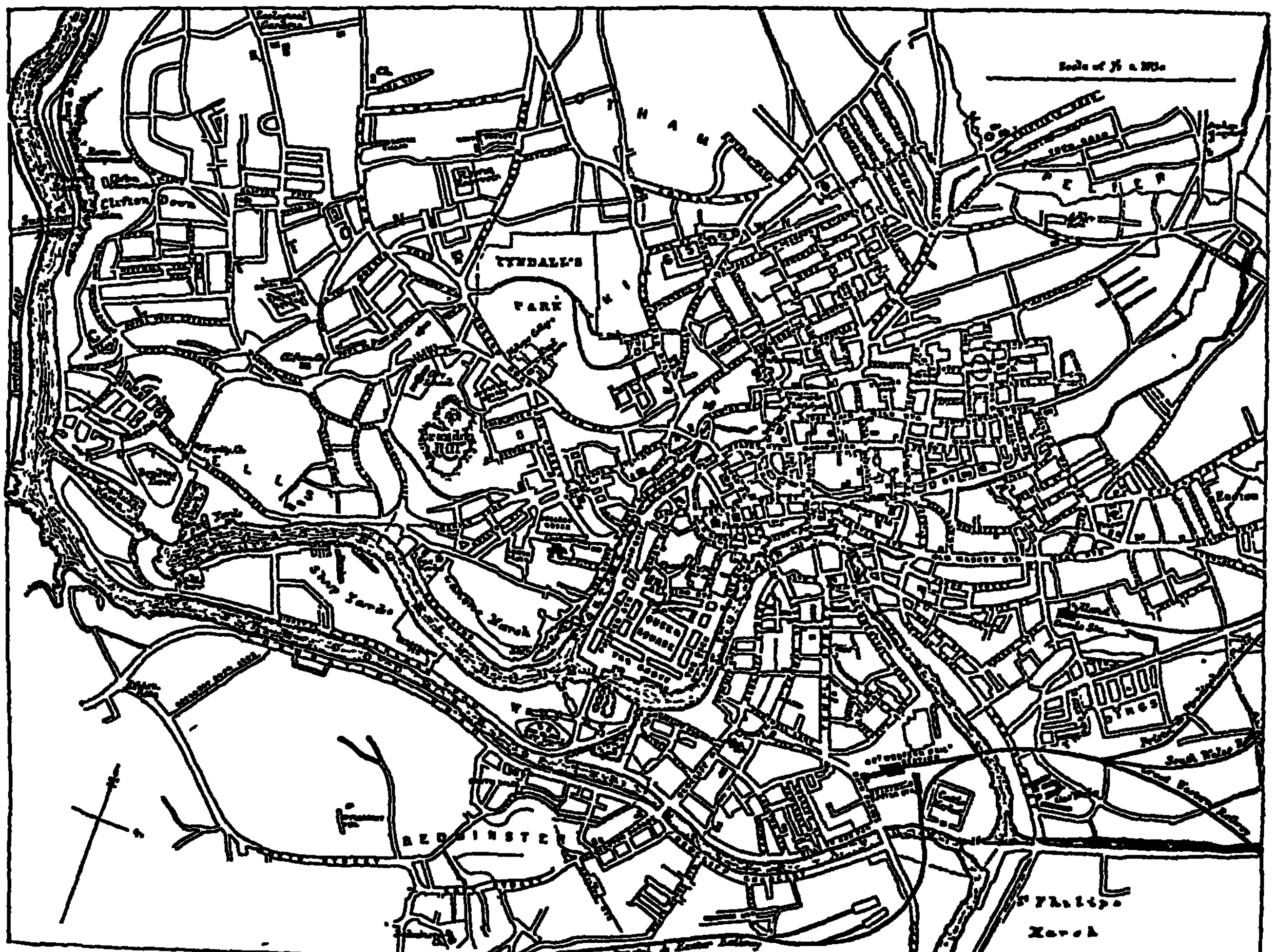
BRISBANE, a town of Australia, capital of the colony of Queensland, is situated in Stanley county, on both banks of the River Brisbane, about 25 miles from its entrance into Moreton Bay. It consists of four parts,—North and South Brisbane, Kangaroo Point, and Fortitude Valley. Among its public buildings are courts of justice, houses of parliament, a governor's residence, a literary institute, a concert-room, a school of arts, and from twenty to thirty churches. It has also an excellent botanical garden. The river, which is about a quarter of a mile broad opposite the town, is navigable for vessels of considerable burden, and has been made more accessible by the partial removal of the bar at its mouth. Regular steam communication is kept up with Sydney and other Australian ports, and a very flourishing trade is carried on in the export of wool, cotton, tallow, and hides, and the import of European manufactures. The town is the centre of a considerable railway and telegraphic system. Brisbane was founded as a penal settlement in 1825, and was named in honour of Sir Thomas M. Brisbane. In 1842 the establishment was abolished, and general colonization set in. The town was politically a part of New South Wales till 1859, when it was made the capital of Queensland. It is the seat of an Anglican and also of a Roman Catholic bishop. Its population was only 5225 by the census of 1861; but in 1871 it amounted to 15,029, of whom 7204 were males and 7825 females. The number of inhabited houses at the latter date was 2931.

BRISBANE, SIR THOMAS MAKDOUGALL, a distinguished soldier and astronomer, was born in 1773 at Brisbane in Ayrshire. He entered the army in 1789, and served in Flanders, the West Indies, and the Peninsula. In 1814 he was sent to North America; on the return of Napoleon from Elba he was recalled, but did not arrive in time to take part at the battle of Waterloo. From 1818 to 1821 he was military commander in the South of Ireland. He was then appointed governor of New South Wales, an office which he held for four years. During that time he devoted himself most earnestly to the colony under his charge; he introduced new plants and breeds of animals, encouraged the reclaiming of waste lands, and even raised the status of the convicts by his wise measure of granting tickets-of-leave for good conduct. While in Australia he occupied himself in astronomical researches, erected a large observatory, and catalogued 7385 stars scarcely before known. The Royal Society awarded him their Copley medal for this work, *The Brisbane Catalogue of Stars.* After his return he resided chiefly at Makerstoun in Roxburghshire, where he had a large and admirably equipped observatory. Three volumes of his observations were printed in the *Transactions of the Royal Society of Edinburgh.* In 1836 he was made a baronet and K.C.B.; and in 1841 he became general. He received the degree of D.C.L. from Oxford, and was elected president of the Royal Society of Edinburgh after the death of Sir Walter Scott. Sir Thomas died on the 31st January 1860. He founded two gold medals for the encouragement of scientific research, one in the award of the Royal Society, the other in that of the Society of Arts.

BRISSON, MATHURIN JACQUES, a French zoologist and natural philosopher, was born at Fontenay-le-Comte, 3d April 1723. He studied for the church, but did not take orders, as his inclination led him towards the study of natural science. He became assistant to the celebrated Réaumur, and in 1756 published the first volume of his work on the animal kingdom, containing an account of the quadrupeds and cetacea. Of his other works on natural history the most important was the *Ornithologie*, 6 vols., 1760. After the death of Réaumur and the amalgamation of his museum with the royal cabinet, Brisson gave up the study of natural history and devoted himself to physical science. He obtained an appointment as professor in the college of Navarre, and was made instructor of the royal family in natural philosophy. Several text-books on physics were published by him, and were in considerable repute for a time, but his most important piece of work was the *Tables of Specific Gravities*, published in 1787. Brisson died in 1806.

BRISSOT, JEAN PIERRE, who assumed the name *De Warville*, a celebrated Girondist, was born of humble parents at Chartres in January 1754. He received a good education, and entered the office of a lawyer at Paris. His first works, *Théorie des Lois criminelles* (1781) and *Bib-*

liothèque philosophique du Législateur (1782) were on the philosophy of law, and showed how thoroughly Brissot was imbued with the ethical precepts of Rousseau. The first work was dedicated to Voltaire, and was received by the old *philosophe* with much favour. Brissot became known as a facile and able writer, and was engaged on the *Mercure*, on the *Courrier de l'Europe*, and on other papers, a connection with which was not creditable to him. He seems, indeed, to have sold his pen readily, and to have degraded himself by being associated with such men as De Morande. Ardently devoted, however, to the service of humanity, he projected a scheme for a general concourse of all the *savants* in Europe, and started in London a paper, *Journal du Lycée de Londres*, which was to be the organ of their views. The plan was unsuccessful, and soon after his return to Paris Brissot was lodged in the Bastille on an unfounded charge. He obtained his release after four months, and again devoted himself to pamphleteering, but had speedily to retire for a time to London. On this second visit he became acquainted with some of the leading Abolitionists, and attempted to set up in Paris a *Society of the Friends of the Blacks*. As an agent of this society he paid a visit to the United States, and returned just at the outbreak of the Revolution. Into this great movement Brissot threw himself heart and soul. He edited the *Patriote Français*, and being a well-informed, capable man, soon began to take a prominent part in affairs. In the National Assembly he leagued himself with the party, well known in history as the Girondists, but then frequently called the *Brissotins*. Of this party he was in many respects the ruling spirit. Vergniaud certainly was far superior to him in oratory, but Brissot was quick, eager, impetuous, and a man of wide knowledge. But he was at the same time timid and vacillating, and not qualified to struggle against the fierce energies roused by the events of the Revolution. His party fell before the "Moun-



Plan of Bristol.

tain;" sentence of arrest was passed against the leading members of it on the 2d June 1793. Brissot, persuaded by his friends, attempted to escape in disguise, but was arrested at Moulins. His demeanour at the trial was quiet and dignified; and on the 31st October 1793 he died bravely with his comrades. His works are numerous, but their interest was merely temporary.

See Mignet, *Revolut. Franç.*; Carlyle, *French Revolution*; and the numerous histories of the period, particularly Lamartine's *Histoire des Girondins*.

BRISTOL, a seaport town in the west of England, is situated in 2° 35′ 28″·6 W. long., 51° 27′ 6″·3 N. lat., 108 miles from London by road, 118 by Great Western Railway, 12 miles N.W. of Bath, and 8 miles inland from Bristol Channel, with which the port communicates by the Avon. That river, as well as the Frome which unites with it at the quay, runs through the city and forms the topographical division between Gloucestershire and Somersetshire, out of which provinces Bristol was constituted a distinct county in itself by a charter of Edward III. Its geological position is on the New Red Sandstone, which rises above the alluvial deposit of the rivers, while deep beneath these layers would be found the coal measures that succeed the millstone grit beds of the adjacent hills (*250 feet in height*) of Brandon and Kingsdown. The origin of the name is doubtful. Mr Seyer, the historian of Bristol, gives forty-two variations in the spelling of the word, and after showing attempted derivations from Brennus, the legendary founder of the town, Brictric, its Saxon lord, &c., finally decides for Brigstow, or Bridge-place, an etymology accepted by the author of *Words and Places*. "In fact, Bristow," says the Rev. John Earle, "is a condensed compound for *Tra-*

jectus ad Abonam;"[1] the place of the bridge at which the Avon was crossed. The vestiges of Roman occupation, however, on the site of the ancient city are scanty, and consist almost solely in the discovery at different spots of some coins of Severus and other emperors. *Caer Brito*, one of the thirty-three early cities of Britain mentioned by Nennius, is interpreted by Henry of Huntingdon (1154 A.D.) to mean Bristol. If (as now municipally) the name include the outlying heights of Clifton this interpretation may be adopted with less hesitation. 300 feet above the surface of the Avon, on both sides of the river, are Belgic British camps, with traces of superadded Roman work, one of which is comparatively perfect, a second of well-marked outline, while a third has been wantonly destroyed within the last two or three years. The existence of coins of Canute, of Harold I., of Hardicanute, of Edward the Confessor and of Harold II., of Bristol mintage, shows that the place was a centre of population under the Danes and Anglo-Saxons, but there is no positive mention of a Danish invasion except by Polydore Vergil, a 16th century historian.

The history of the town hardly begins till the subjugation of Gloucestershire by the Conqueror, in 1068. Bristol is not specially named, but there is no reason to believe that it offered any futile resistance to the sweeping tide of conquest. Early in the following year, three sons of Harold,—Godwin, Edmund, and Magnus,—resolving to reconquer the kingdom their sire had lost with his life, came at the head of fifty-two ships from Ireland up the Bristol Channel, and laying waste the coast on their way, sailed up the Avon to Bristol. Here they were sharply repulsed by the townsmen, and afterwards more thoroughly routed by Geoffry Mowbray, bishop of Coutance, nephew to the famous Tancred the crusader (*Biog. Univers.*) Though Bristol is mentioned in *Domesday*, Bristol Castle is not,

Obverse. Reverse.

Corporation Seal (Motto: *Virtute et Industria*).

but appears first in history in connection with the constableship of the martial prelate just named, who held the fortress for Robert duke of Normandy against William Rufus. When the king had crushed the insurrection and driven the rebel churchman out of the realm, he granted the royalty, or Honour of Gloucester, which included Bristol, to his kinsman Robert Fitzhamon, who thus became feudal chief of the territory Fitzhamon's daughter, Mabel, marrying Robert earl of Gloucester, natural son of Henry I., that noble, upon the death of his father-in-law, became lord of the tower and town of Bristol. He rebuilt the castle, which soon received as captive within its walls Robert duke of Normandy, who was afterwards removed to Gloucester's stronghold at Cardiff. The red earl of Gloucester, as he was called, was the most powerful baron of his age; and among his successes in war, was the capture of king Stephen at the battle of Lincoln, who was brought to Bristol, and, like Curthose, imprisoned in the castle, where he remained in chains till exchanged for Gloucester himself, who in his turn was defeated and captured by Stephen's queen at Winchester. Earl Robert died in 1147 and was succeeded by William his son, whose daughter, Avisa, marrying John earl of Moreton, afterwards king John, the town and castle of Bristol became an apanage to the crown, and as such it continued to the time of Charles I. John was as many as nineteen times at Bristol, the neighbouring forest of Kingswood, which stretched 14 miles square to the east of the city, no doubt resounding frequently to the cry of his hunt.

Henry III., upon the death of John, came for security to Bristol Castle, when he permitted the town to choose a mayor after the manner of London; and in like usage that the mayor of London was sworn before the constable of the Tower, so here he was directed to be sworn before the constable of the castle of Bristol, each fortress being distinct from its respective city. This feudal custom was continued here until Edward III. conceded, among other chartered benefits, that the new mayor should take oath of office before the retiring mayor in the Guildhall of Bristol in the presence of the commonalty. Other privileges from the same monarch were the establishment here of the wool-staple, and the empowering of the mayor and sheriff to elect from time to time forty of the "better and more honest" men of the town, as a council to rate and levy taxes, &c., which common council, in nearly the same form as instituted, is yet maintained.

Richard II. confirmed all the grants of his predecessors, and directed that the steward and marshal and clerk of the royal household should not sit in the town of Bristol, as before had been granted to the city of London. In 1387 the king was at Bristol castle "with," says Froissart, "the queen and all the ladies and damsels of her court," having accompanied thus far his favourite, De Vere, towards Ireland. Two years later Henry Bolingbroke, with his vast northern army, surrounded the walls of this important western city which immediately surrendered. After four days' siege the castle also capitulated, one of the terms of the treaty with the duke of York, agreed to by its governor, Sir William Courtnay, being that Lord Scrope, earl of Wilts, Sir Henry Green, and Sir John Busbie, who were within its walls, should be delivered into the hands of the duke of Lancaster. In Shakespeare's *Richard II.* is a scene wherein Bolingbroke denounces these minions of the falling cause, and orders Lord Northumberland to see them despatched. They were beheaded in the centre of the town, where then stood the high cross. Only a few years since an unsuccessful attempt was made in the House of Lords to revive the peerage of Wilts, which included the right to wear a kingly crown in the Isle of Man, that peerage having been dormant from the time Sir William Scrope here lost his head. In 1408 Lord Spencer, another adherent of the ruined dynasty, was also executed at the same spot.

By a charter of Henry VI. the town of Bristol, with its gates, ditches, walls, and markets, was farmed to the mayor and burgesses for sixty years at the annual rent of £102, 15s. 6d. to the king's household, and £57, 4s. 6d. to the abbot of Tewkesbury and to the castle. This yearly fine of £160 was granted by Edward IV. to Elizabeth his queen consort Richard III. released £60 of this rent, and the remainder was redeemed in the reign of Charles I.

The doctrines of the Reformation were preached here by Tyndale, Cranmer, and Latimer. The issue of the dissolution of religious houses, of which thirteen encircled the outer walls of the city, was the erection here of a bishopric (1542) by the conversion of the abbey church of Austin canons into a cathedral. It has singularly escaped the notice of every writer that the episcopate was refounded in 1551, by power of letters apostolic directed by Pope Paul IV. to Cardinal Pole; a MS. copy of the original Bull is in the Bristol Museum. The transitional epoch from the Papal to the Protestant faith was stained here by the

[1] *Arch. Inst. Jour.*, vol. xviii. 350.

blood of five martyrs; to which number we may add a sixth, James Duke, who belonged to Bristol, but suffered in Kent. About the beginning of autumn 1559 "the church wardens of all the churches of Bristow," says an unpublished chronicle noticed below, "and some of the ministers, brought forth their roods and other images, which were in their churches, to the High Cross where they were burnt."

The detachment of the castle from the county of Gloucester, and its grant to and incorporation with the town of Bristol by Charles I. (1629) at the request of Henrietta Maria, was another important surrender from the Crown, but the charter cost the city £949, and the castle was to be holden at a fine of £40 yearly. As London was called the King's Royal Chamber, so Bristol was called the Queen's Royal Chamber; but courtly favours were all practically cancelled by the infliction of the ship-money tax. By the king's writ (of October 20, 1634), £6500 was charged on Bristol for this impost, and there were further taxations in successive years. The payment of these assessments became at length so dilatory as to draw down (1638) a sharp reprimand from Government upon the mayor, with the threat,—"if you give not his majesty better satisfaction we shall take a course to make you sensible of your duty" (*Cal. State Papers*).

The hurtful interference with the trade of the place (such as the limitation in the manufacture of soap to 600 tons yearly, which article had been from the 12th century, and is even now, one of the chief of Bristol productions) prepared the way for the easy admission of Col. Essex and his troops, when in 1643 he presented himself before the gates of the city. The Parliament held the place from 5th December 1642 to 26th July in the following year, when Prince Rupert, with his cavaliers, surrounded the walls, and storming at all points frightened the governor, Col. Fiennes, who had succeeded Essex, into capitulation. In August 1645 the city was assaulted by Fairfax and Cromwell, and on the 20th day of the siege, it having been heard that the king was in full march upon the west, a storm was decided upon, and after a sharp assault on the 11th of September, Rupert surrendered. "We had not killed of ours in the storm," says Cromwell, "nor in all this siege, two hundred men. He who runs may read that all this is none other than the work of God. He must be a very atheist that doth not acknowledge it." Ten years later the castle was demolished by order of the Protector. The history during the next century and a half is unmarked by any very striking events. The rise of Nonconformity; the persecution of the Quakers, of whom 103 were in Bristol prisons at the accession of Charles II.; the visit of the sanguinary Jefferies on his famous western assizes, when six persons were condemned and executed on Redcliff hill, are some of the chief phases and incidents during this period. In 1684 was given the charter granting that "the citizens and inhabitants of Bristol and their successors hereafter for ever may and shall be a body corporate in deed, fact, and name, by the name of *the Mayor, Burgesses, and Commonalty of the City of Bristol*, with a common seal." In 1685 James II. stopped here on his way to Sedgemoor; and he again visited Bristol in the following year, and was handsomely entertained. The bishop of Bristol at the time was Lake, one of the historical seven, who was succeeded by Trelawny, another of the seven. The greatest merchant in Bristol at this period was Edward Colston, whose profuse benevolence has made his name splendid among the citizens. In the foundation of schools and almshouses, repairs of churches, &c., he gave £70,695, a vast sum in these days. He died in 1721. Three influential societies instituted to his memory yearly assemble at public dinners, where they collect alms for lying-in women, for apprenticing boys, &c. Up to the end of 1874 the amounts collected from their commencement by these—the Dolphin, Anchor, and Grateful societies—have attained an aggregate of £118,013. At the election of 1774 Bristol was represented in the person of the famous Edmund Burke, but his policy did not please all his constituents, and he consequently lost his seat here for the next Parliament. His defensive speech on the hustings of Bristol "is one of the most convincing pieces of popular oratory on record." The Bridge Riots of 1793 and the Reform Riots of 1831 are dark spots on the history of *Bright-stow*, or Bright-place, as old Fuller interpreted the name. The former were the result of opposition to the prolonged impost of toll which it was prevalently understood was to cease by a certain day. About forty persons lost their lives by a charge of the military on this occasion. The Reform Riots have been called "The Bristol Revolution," but were simply a revolt of the lowest stratum of society, in whom mania for plunder superseded all political principle. Forty-five houses, the bishop's palace, and the prisons were burnt to the ground; twelve of the rioters were killed by the soldiers, several perished in their own fires, four were hanged, thirty were imprisoned; the colonel of the troops committed suicide, and the city was mulcted in £68,208 damages. The next year the cholera visited the people, when 626 died of the malady.

The nautical enterprise of Bristol has been worthy of a place that "seems to swim on the waters" and struck the eye of Pope the poet as having its streets full of ships. Some remarkable voyages from the port are recorded, but perhaps none more memorable than that of Sebastian Cabot in 1497, who was the first Englishman (for he was born in Bristol) who landed in America, and the earliest to discover that portion of the continent now called the United States, and thereby to secure its English colonization. The notice in a hitherto unpublished local chronicle is as follows:—"This year (1497), on St John the Baptist's day, the land of America was found by the merchants of Bristowe in a ship of Bristol called the 'Matthew,' the which said ship departed from the port of Bristowe the 2d of May, and came home again 6th August following."[1] A Bristol privateer brought home from Juan Fernandez the real Robinson Crusoe. The saucy "Arethusa" frigate, celebrated for naval daring by Dibdin in song and by Capt. Chamier in romance, was built at and belonged to Bristol. The first steamboat built and fitted at the same port was the "Wye," in 1827. Bristol was the first city in the kingdom that established regular steam communication with the United States, the first voyage having been made by the "Great Western" in 1838. This vessel was built at Bristol at a cost of £60,000. The "Great Britain" and the ill-fated "Demerara" were also built here, the former costing £120,000.

The creation of Bristol a free port in 1848 has resulted in great increase of trade. The tonnage of foreign vessels (exclusive of Ireland) with cargoes entering the town, was in 1846, 100,722; in 1873, 411,014; in 1874, 432,940. The quantity of grain of all kinds imported between April 1874 and April 1875 was 1,062,007 quarters; of wine, 7459 pipes; of timber, 34,740 tons; of sugar, 83,858 tons. With respect to the shoe manufacture, in January 1657, leave was given by Government to Mr Ellis of Bristol, to send 1000 dozen of shoes to Barbadoes, and another 1000 dozen in December. The combined shoe trade now employs 5000 hands, one firm, Derham's, alone paying in wages £50,000 per annum. Fry's chocolate and cocoa works occupy between 500 and 600 hands. The soap trade engages about 400 hands. In the Great Western Cotton Works about 1500 are employed; in the stay trade 2000 people.

Bristol stands fourth of all the seaport English towns in the amount of customs revenue received. The gross amount in 1864

[1] These important dates have not (at least the two latter) till now been published. They are from an ancient manuscript for several generations in possession of the Fust family of Hill Court, Gloucestershire, the "collations" of which are now (1876) in the keeping of Mr William George, bookseller, Bristol.

was £1,103,000; this had increased in 1866 to £1,174,181, and decreased in 1873 to £941,679. The inland revenue received in the year 1874-5 was £467,091.

The boundaries of the city within its ancient limits comprised 755 acres, and the districts added by the Municipal Act (5 and 6 Wm. IV.) contained 4124 acres, making a total of 4879 acres. The population of the ancient city and of these districts according to the census returns of the present century has been as follows:—

Year.	Ancient City.	Added Districts.	Total.
1801	40,814	20,339	61,153
1811	46,592	24,891	71,483
1821	52,889	32,219	85,108
1831	59,074	45,334	104,408
1841	64,266	60,880	125,146
1851	65,716	71,612	137,328
1861	66,027	88,066	154,093
1871	62,662	119,890	182,552

The entire rateable value in 1861 was £508,988; in 1871, £719,983. The circuit of the municipal boundaries is 15 miles. The town is divided into 10 wards, returning 48 members to the town council, selected by the burgesses, with 16 aldermen, chosen by the council,—64 members in all. There are 30 acting justices of the peace, appointed by the lord chancellor, the mayor being chief magistrate. Bristol returns two members to Parliament.

The amount of the poor-rate levied from house to house by the churchwardens in 1696 (the year before the Incorporation Act) was £2145. At the present time it is £36,000, in addition to the other rates. The rateable value for poor-rate in 1874 was £759,441, at about 1s. 9d. in the pound, or £66,451, 1s. 9d. The local taxation in 1874 was an average total of 5s. 4½d. in the pound. The amount paid in 1874, not including shipping dues, was £187,573.

Architecture and Public Buildings.—To a few great baronial families—the earls of Gloucester, the Berkeleys, and the Gaunts—in its early history, and to a few great merchants—the Canyngs, the Shipwards, and Framptons—in its later career, the architecture, principally ecclesiastical, for which Bristol is famous, has been due. Though much of this has been destroyed, much remains. Robert Fitzhamon's Norman tower of St Peter, the oldest church tower in Bristol, still presents its massive square to the eye. Of the castle of Robert earl of Gloucester, the walls of which were 25 feet thick at the base, nothing remains, but there still exist some walls and vaults of the later stronghold, including a fine Early English cell. The grand nave of St James's church, which the same noble also erected, and wherein he was buried, yet stands. Of Fitz Harding's abbey of Austin canons, founded in 1142, the stately entrance gateway, with its sculptured mouldings, has hardly been injured by seven centuries' exposure to rudeness of weather and greater rudeness of men. The abbot's gateway, the vestibule to the chapter room, and the chapter-room itself, which is carved with Byzantine exuberance of decoration, and acknowledged to be one of the grandest Norman rooms in Europe, are also perfect. The Early English lady chapel, the geometrical east window, and the side aisles in their singular design and beauty are other specific features of the abbey church, now the cathedral. The nave just added to the 14th century structure has cost to the present time £40,000. Besides the canopied tombs of the Berkeleys with their effigies in chain mail, and similarly unique tombs of the crosiered abbots, there are memorials to Bishop Butler, to Sterne's Eliza, and to Lady Hesketh the friend of Cowper, who are all here interred. Also there is here Mason's touching epitaph: "Take holy earth, &c.," and monuments by Baily and Chantrey. All Hallow's church has a modern Italian campanile, but is in the main 15th century, with the retention of four Norman piers in the nave; and is interesting from its connection with the ancient guild of calendars, whose office it was "to convert Jews, instruct youths," and keep the archives of the town. Theirs was the first free library in the city, possibly in England. The records of the church contain a singularly picturesque representation of the ancient customs of the fraternity. The chapel of the Gaunts is 13th and 14th century, and presents with its rich panelled roof, pictured windows, carved tabernacles and tombs, a concentration of mediæval Gothic art. Of St Michael's, St Thomas's, and Werburgh's, only the towers (15th century) are preserved of the old structures. St Nicholas church is modern, on a crypt of the date 1503 and earlier. Temple church, with its leaning tower, 5 feet off the perpendicular, retains nothing of the Templars' period, but is a fine building of the Decorated and following style. The tower and spire of St John's (15th century) stand on one of the gateways (same date) of the city. This church is a parallelogram, without east or west windows or aisles, but is built upon a groined crypt. St Mary le Port and St Augustine the Less are churches of the Perpendicular era, and not the richest specimens of their kind. St Philip's has an Early English tower, but its external walls and windows are for the most part debased Perpendicular. St Stephen's church, built between 1450 and 1490, is a dignified structure, but is chiefly interesting for it fan-traceried porch and stately tower, the latter being hardly surpassed by any parish tower in England. It was built entirely by the munificence of John Shipward, a wealthy merchant. The crown of Bristol architecture is, however, the church of St Mary Redcliff, which for grandeur of proportion, and elaboration of design and finish, is entitled to stand in the selectest rank of English parish churches, and might be compared with a lesser cathedral. It was built for the most part in the latter part of the 14th century by William Canyng, but the sculptured north porch, which has cost £2535 to restore, is externally Decorated, and internally Early English. The fine tower is also Decorated. The spire just added has cost £5500. The restoration of the church has extended over thirty years, at an expense of £40,000.

Among conventual remains, of the Dominican priory there exist the Early English refectory and dormitory, the latter comprising a row of fifteen original windows and an oak roof of the same date; and of St Bartholomew's hospital there is a double arch, with intervening arcades, also Early English. The small chapel of the Three Kings of Cologne, and Holy Trinity Hospital, both Perpendicular, comprise, with the remains of the Austin canonry attached to the cathedral, nearly the whole of the monastic relics.

There are many good specimens of ancient domestic architecture,—notably some arches of a grand Norman hall and some Tudor windows of Colston's house, Small Street; Canyng's house, with good Perpendicular oak roof; and St Peter's Hospital, Jacobean and earlier.

In all there are 42 Episcopal churches, and 81 dissenters' chapels,—the latter comprising 10 Baptist, 19 Congregationalist, 11 Wesleyan, and 5 Roman Catholic (besides 6 convents). The Exchange is a quadrangular colonnade, with a noble frontage by Wood of Bath. The Guildhall is modern Tudor Gothic. The Bristol Museum and Library is a fusion of the two leading philosophical and literary societies of the district, a spacious building in the Venetian Gothic style, having been built for their joint purposes. The geological collection is among the best provincial collections; the library (40,000 vols.) is the largest in the west of England. There is also a free library, under the Act.

Among the endowed public schools are (1), the Cathedral school, founded 1542, and Cathedral college (1876); (2), the Grammar school, which has secured a high position, and has right of presentation to two university scholarships; (3), Queen Elizabeth's Hospital for 200 boys, who are educated and clothed free; (4), Colston's school; (5), Baptist college for educating young men for the Baptist ministry; (6), Redmaids' school for 120 girls, free. A Girls' Reformatory school, the first established under the Act, owes its origin to Miss Mary Carpenter, who is still lady superintendent. Up to

the end of 1874 there have been in this school 417 girls, of whom 66 were still there. During the last 4 years 87 have left, of whom 64 were earning a creditable living. The Royal Infirmary administered in 1874 to 2792 in and 23,163 out patients; the General Hospital to 1404 in and 13,512 out patients. Muller's Orphan House comprises five buildings, which have cost £115,000. The average number of inmates is 2000 children and 120 officials. The average cost of each child, exclusive of salaries, is £13 a year. Nearly £600,000 has been given for the furtherance of the work since it was begun in 1836. There is a school-board in Bristol, with 20 attached schools, and 113 schools under inspection.

See Barrett's *History of Bristol*, 1789; Seyer's *Memoirs of Bristol*, 1821; Dallaway's *Antiquities of Bristow*, 1834; Evans's *Chronological History of Bristol*, 1824; Bristol vol. of *Brit. Archæolog. Inst.*; Taylor, *Book about Bristol*, 1872; *Bristol and its Environs*, 1875.

BRISTOL, a town of the United States, the capital of a county in Rhode Island, is situated on a peninsula between Narraganset Bay and Mount Hope Bay, 16 miles S.E. of Providence by rail. Its trade and manufactures are considerable, but it is chiefly important as a summer watering-place. There is direct steamboat communication with Providence and New York. During the War of Independence the town was nearly destroyed by the English. Population in 1870, 5302.

BRITANNIA. The history of Britain begins with the invasion of Julius Cæsar, 55 B.C. Cæsar is the first Roman writer who mentions Britain; before him we have only a few short notices in Greek writers, who appear to have known but little about the country. The earliest notice of Britain is in Herodotus (450 B.C.), who mentions the *Tin Islands*, only to confess his ignorance about them. By the Tin Islands are probably to be understood only the Scilly Isles and Cornwall, which are said to have been known to Phœnician traders some centuries before the Christian era.

More important is a passage in Aristotle, who, writing a century later than Herodotus, is the earliest writer who mentions the British Isles by name. The passage is in the *De Mundo*, c. 3,—"Beyond the pillars of Hercules (Straits of Gibraltar) the ocean flows round the earth, and in it are two very large islands called British (βρετανικαὶ λεγόμεναι), Albion and Ierne, lying beyond the Keltoi." The application of the name Britannia, to denote the larger island, is first found in Cæsar.

The etymology of the name Britannia is uncertain. Of the numerous derivations which have been proposed the most generally adopted is that which connects the word with a root *brith* (*variegatus*), in supposed allusion to the British practice of staining the body with woad; but this is not to be considered as perfectly satisfactory.

The earliest inhabitants of Britain concerning whom we have any certain knowledge are the Celts, who formed the vanguard in the great westward migration of the Indo-European or Aryan nations; but it seems certain, from the evidence of remains found in the country, that the Celts were preceded in their occupation of it by a non-Aryan race.

The Celtic family is divided into two branches—the Gaelic and the Cymric. To the former belong the Irish and the Highlanders of Scotland, to the latter the Welsh and the inhabitants of Britanny, and to these may be added the ancient Gauls, the remains of whose language seem to prove without doubt that they belonged to the Cymric and not to the Gaelic branch.

Of the Celtic inhabitants of Britain nothing is known before the time of Cæsar, whose account of them is the earliest which we possess. Somewhat abridged it is as follows:—

"The interior of Britain is inhabited by a race said to be aboriginal, the coast by invaders from Belgium, who having come over for the sake of spoil have settled in the country. For money they use either copper or pieces of iron of a certain weight. Tin is found in the interior of the country; iron on the coasts, but the quantity is small; copper is imported. The timber is of the same kinds as in Gaul, except the beech and the fir. The climate is more temperate than in Gaul, the cold being less severe."

After a short geographical description of the island, Cæsar proceeds to speak of the inhabitants—

"By far the most civilized are the inhabitants of Cantium (Kent); they do not differ much in their customs from the Gauls. The inhabitants of the interior do not for the most part sow corn, but live on milk and flesh, and clothe themselves with skins. All the Britons stain themselves with woad, which produces a blue colour, and gives them a more formidable appearance in battle. They wear their hair long, and shave every part of the body except the head and the upper lip. Ten or twelve have wives in common. (Cæs., *B. G.* v. 12–14).

Nothing is here said as to the religion of the Britons; and we are obliged to turn for information on this head to Cæsar's account of Druidism in Gaul. We are justified in so doing by Cæsar's statement that the religious system of the Gauls was devised in Britain, and that it was still the custom for those who wished to become thoroughly versed in it to go thither for the sake of instruction. Having said that besides the common people, who are of no account and are little better than slaves, there are in Gaul two orders,—the Druids and the Knights,—Cæsar goes on to give an account of the former—

"The Druids are engaged in matters of religion, and have the care of public and private sacrifices. They are the arbiters in almost all disputes, public and private, and assign rewards and punishments. Whoever refuses to abide by their decision is excluded from the sacrifices, and thereby put outside the pale of the law.

"The Druids are exempt from military service, and from the payment of taxes. Their chief doctrine is that souls do not perish with their bodies, but are transferred after death to other bodies."—(*B. G.*, vi. 13–14.)

These are the leading points of Cæsar's short account of the Druids, which is the earliest we possess, and is the main foundation on which has been raised the elaborate Druidic system of later writers.

Politically, Britain consisted of a number of independent tribes united in a federation of the loosest kind, in which the lead was taken by the tribe which happened at any time to be the most powerful.

The Britons appear to have kept up a tolerably close intercourse with the Continent. They are first mentioned by Cæsar as sending aid to the Veneti (a Gaulish tribe whose name is preserved in that of the present town of Vannes), in their revolt against the Roman power. This was in 56 B.C.; and in the following year Cæsar resolved on an invasion of Britain, partly influenced, no doubt, by the desire of taking vengeance for the help afforded by the Britons to his enemies the Veneti. C. Volusenus having been previously sent to examine the British coast, Cæsar himself set sail from Portus Itius (probably Wissant, between Boulogne and Calais) on the night of the 26th of August 55 B.C., taking with him two legions. The opposite coast was reached early on the morning of the following day, and after a sharp struggle a landing was effected apparently somewhere near Deal. Slight resistance was now offered by the Britons, to whom peace was granted on easy terms, and the Romans hastened back to Gaul.

Early in the following summer Cæsar again started from Portus Itius, this time with a force of five legions and a corresponding body of 2000 cavalry, and landed on the coast of Britain at the same place as in the previous year. Leaving a small force to protect the ships he advanced twelve miles inland to the River Stour before meeting with the enemy. Cassivellaunus, chief of the country to the north of the Thames, had been chosen by the Britons as their general-in-chief, and under his command they for a time presented a fierce resistance to the invaders, but they were unable to withstand the steady onset of the Romans, and Cæsar soon reached and took by storm Cassivellaunus's capital. The site of this city is now unknown, but it has been

conjectured with some probability to have been Verulamium (St Albans). Cassivellaunus now sued for peace, and after receiving hostages and fixing the amount of the tribute Cæsar left the country before the end of the summer. No garrison was left behind to secure the Roman conquests, which were thus practically relinquished. For nearly a hundred years after this date the history of Britain is almost a blank. The Emperor Claudius, on his accession to the empire in 41 A.D., determined to carry out Augustus's intention of exacting the British tribute; accordingly (43 A.D.) Aulus Plautius was sent to Britain with a force of four legions, and having landed without opposition, he advanced to the northern side of the Thames, and there awaited the emperor's arrival. Plautius was soon joined by Claudius, who at once led his army against the Britons, over whom he gained a complete victory, immediately after which he returned to Rome, leaving Plautius to secure his conquests.

The war was now carried on in the west between the Roman general Vespasian, who afterwards became emperor, and the Silurian chief Caractacus (Caradoc). After a struggle of nine years Caractacus at length, in 51 A.D., met with a decisive defeat at the hands of P. Ostorius Scapula. Having fled for refuge to Cartismandua, queen of the Brigantes (a tribe occupying the district between the Tyne and the Humber), he was betrayed by her to the Romans, by whom he was taken to be led in triumph through the streets of Rome.

Ten years after this Boadicea, queen of the Iceni, a tribe occupying the present counties of Norfolk and Suffolk, took advantage of the absence in Mona (Anglesey) of the Roman prefect, Suetonius Paullinus, to excite her people to revolt. The Roman colony of Camulodunum (Colchester) was taken and sacked, and the rebellion soon seemed seriously to threaten the Roman power. Suetonius, however, hastened up from the west, and in a single battle, fought near London, inflicted a decisive defeat on the Britons, following up his victory by a massacre in which 80,000 Britons are said to have perished. Boadicea poisoned herself to avoid falling into the hands of the Romans. The spirit of insurrection was now completely crushed; a milder policy was adopted by the successors of Suetonius, and Roman civilization began rapidly to spread over the country.

The next event of importance is the arrival of Agricola as governor of Britain in year 78. Agricola's first task was to complete the subjection of the Ordovices (North Wales), and this having been speedily accomplished, he adopted, with great success, a policy of conciliation. He encouraged education and building, and succeeded in introducing Roman dress and manners among the Britons. This, says Tacitus, they in their ignorance called civilization, though it was but a part of their slavery. In 79 Agricola attacked the Brigantes, and reduced the country betwen the Humber and the Tyne. During five years he continued to advance further north, and in 84 he defeated a Caledonian chieftain, named Galgacus, in a great battle, the site of which it is impossible to fix, but it was probably not far from the eastern coast of Scotland at some place north of the Tay. Agricola was now recalled to Rome, and no attempt was made to maintain the conquests north of the line of forts which he had built between the Forth and the Clyde.

The remainder of the period of the Roman occupation is for the most part uneventful. In 120 the Emperor Hadrian visited the country, and built a rampart between the Tyne and the Solway Frith, in order to check the inroads of the northern tribes. In 139 a wall, called the wall of Antonine, in honour of the emperor Antoninus Pius, was built by the prefect Lollius Urbicus along the line of Agricola's forts between the Forth and the Clyde. In 207 the Emperor Severus came to Britain in order to lead in person an expedition against the Caledonian tribes. He advanced far into Caledonia, driving the enemy before him but never meeting them in a pitched battle. No substantial advantage was gained in this desultory war, which cost the lives of 50,000 Roman soldiers. Severus built a new wall along the line of Hadrian's rampart, and died at York in 211.

The Roman empire was now in a state of decay, and its weakness offered great temptations to distant officials to seize the supreme power for themselves. About 287 the title of emperor was assumed by a man of low birth named Carausius, a native of Menapia (the district between the Scheldt and the Meuse), who had been appointed to the command of the fleet stationed in the English Channel for the purpose of protecting the coasts of Britain and Gaul from the Frisian pirates, and whose conduct in that position had been such as to draw from the emperor Maximian an order for his death. After a successful reign of seven years, in the course of which his independence was acknowledged by Maximian, Carausius was assassinated by his chief officer Allectus, who in his turn usurped the imperial title during three years, at the end of which Britain was regained for Rome by Constantius Chlorus (296). Constantius afterwards led an expedition into Caledonia, and died at York in 306.

Soon after this date the Picts and Scots begin to be heard of as invading the Roman province from the north. The Scots, who occupied the western part of Caledonia, belonged to the Gaelic branch of the Celtic family, and had crossed over from Ireland, bringing with them the name which was afterwards bestowed on their new home. The question as to the origin and the language of the Picts is one which has been long under discussion, and still seems far from a definitive settlement. The Picts are now, however, generally admitted to have been a Celtic race, and the evidence of language, as far as can be judged from the very few Pictish words, chiefly proper names, which have been preserved to us, seems to indicate the Cymric rather than the Gaelic as the branch to which they belonged. (For further information on this point see Garnett, *Philological Essays*, and Skene, *The Four Ancient Books of Wales*. Garnett holds the view that the Picts were a Cymric race; Skene believes them to have belonged to the Gaelic branch of the Celtic family.)

In 367 the Picts and Scots overran the whole country as far south as London. Theodosius, father of the emperor of that name, was sent against them, and in two campaigns he succeeded in driving them back beyond the wall of Antonine. The district thus regained between the walls of Hadrian and of Antonine was named Valentia, in honour of the reigning emperor Valentinian. This, however, was only a momentary check, and the new province was soon lost.

In 383 the title of emperor was assumed by Maximus, a native of Spain, who had served under Theodosius in the Pictish wars. Maximus took a large army of Romans and Britons into Gaul and was recognized by Theodosius and Valentinian as sole emperor over Britain, Gaul, and Spain. Five years later he invaded Italy, but was taken and beheaded at Aquileia in 388. The army never returned to Britain, which was thus left weaker than ever. In 396 a single legion was sent by Stilicho, and the Picts were once more driven back. In 407 three successive emperors—Marcus, Gratian, and Constantine—were set up in Britain, the last of whom followed the example set by Maximus, and carried the army into Gaul, leaving Britain again helpless against the northern invaders. In 410 the Roman occupation of Britain was formally terminated by a letter addressed by the emperor Honorius to the cities

of Britain, in which he told them that they must henceforth be their own defenders.

Britain first became a Roman province in the reign of the emperor Claudius, 43 A.D. It was governed by a single prefect until the reign of Severus, who divided the province into two parts, called Britannia Superior and Britannia Inferior, each governed by a prefect. In the division of the empire into four prefectures in the reign of Diocletian, Britain formed part of the prefecture of Gaul, and was governed by an officer called the *vicarius*, residing at York. The country was subdivided into four provinces, each governed by a prefect:—

1. *Britannia Prima*, the district south of the Thames.
2. *Britannia Secunda*, the district south of the Dee and west of the Severn.
3. *Flavia Cæsariensis*, east of the Severn.
4. *Maxima Cæsariensis*, the district between the Humber and the Tyne.

To these was added as a fifth province the district of *Valentia*, conquered by Theodosius in 368, but it appears to have remained but a short time in the possession of the Romans.

Our knowledge of the events of the two centuries succeeding the close of the Roman occupation of Britain is rendered most uncertain by the absence of contemporary records. The accounts given by later writers, British and Saxon, cannot be relied upon for more than the barest outline, which may be accepted in so far as it is found to be consistent with the visible results of the events of this period.

The paternal character of the Roman rule had left the Britons at its withdrawal enervated and helpless, and utterly unable to cope with the Picts, who now began to press heavily on them. Having in vain appealed for help to the Romans, the Britons applied to the Teutonic rovers who had since the later years of the Roman period been in the habit of plundering the eastern coast. Accordingly, the three tribes of Angles, Jutes, and Saxons came over, and with their assistance the Picts were driven back into their own territories. The Saxons, however, still continued to arrive in large numbers, and soon finding the occasion of a quarrel, they combined with the Picts against the Britons, and proceeded to overrun the country, driving the Britons before them into the west. The first Teutonic kingdom in Britain was that of Kent, founded in 449; and at the end of two centuries we find the Saxons in firm possession of the greater part of the country, and the Celtic tribes occupying only the extreme west. Of Arthur, the hero of the Welsh account of this period, it is impossible to speak with any certainty Although he is unknown to the Saxon chronicle, it seems unnecessary to deny his existence, and it is certain that no part of the south-western district of England, which is generally supposed to have been the scene of his exploits, was conquered by the Saxons until after the time of his alleged victories. An attempt has lately been made (see ARTHUR) to show that the scene of Arthur's victories is to be laid in the south of Scotland, and not in the west of England. The question is one which hardly seems capable of a satisfactory settlement. For the subsequent history see ENGLAND.

See *Monumenta Historica Britannica*, 1848; Camden's *Britannia*; W. B. Jones, *Vestiges of the Gael in Gwynedd*; Merivale, *History of the Romans under the Empire*; Burton, *History of Scotland*, vol. i. (A. W. K. M.)

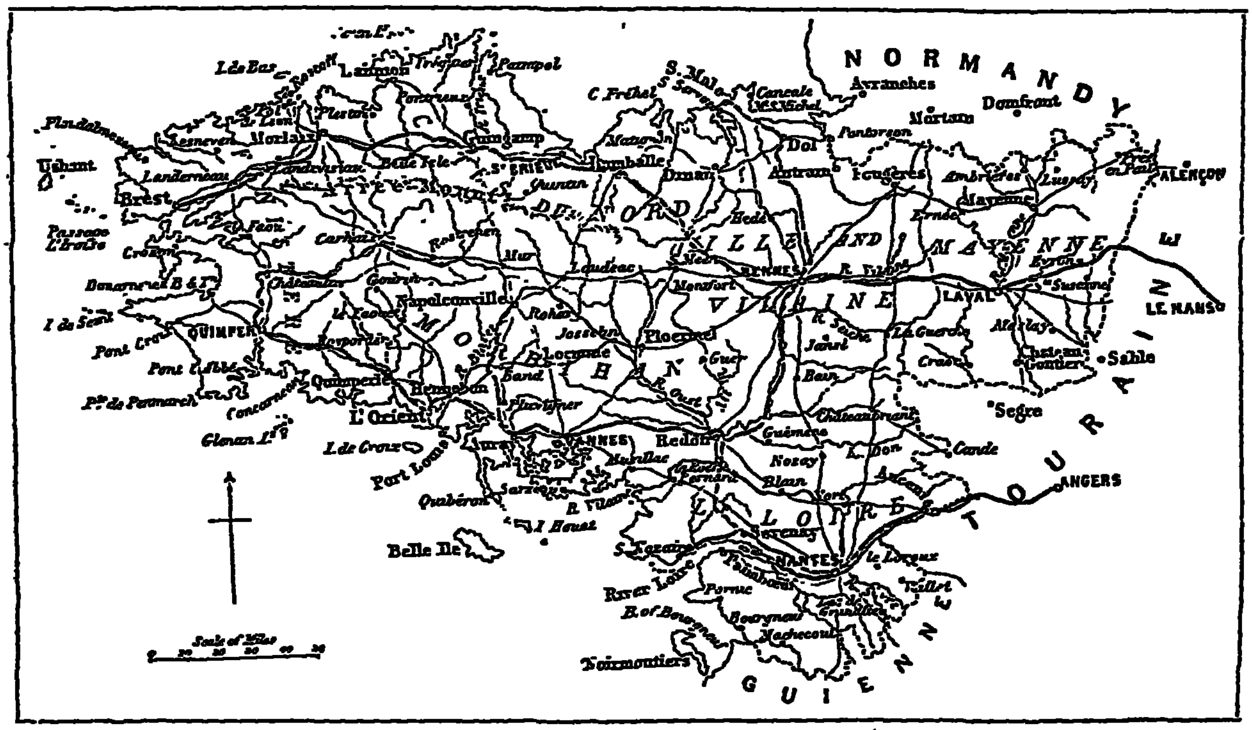
BRITANNICUS, son of the emperor Claudius, and of his third wife Messalina, was born probably 42 A.D., though the exact date cannot be determined. He was originally called Claudius Tiberius Germanicus, and received the name Britannicus on account of the conquests made in Britain about the time of his birth. Till 48 A.D., the date of his mother's execution, he was looked upon as the heir to the imperial dignity, but Agrippina, the new wife of Claudius, soon persuaded the feeble emperor to pass him over and adopt her son by a previous marriage, Lucius Domitius, known later as Nero. After the accession of Nero, Agrippina, whose lover, Pallas, had been banished, threatened to stir up revolt against the new emperor, and excited his fears against Britannicus. Poison was administered to the young prince, at first without effect, but a stronger dose given at the banquet table was instantaneously fatal. The murdered boy, for he had barely completed his fourteenth year, was buried on the evening of the day in which he died. The pile was erected on the Campus Martius amidst a deluge of rain, which washed the plaster and paint from the livid and distorted face of the corpse.

BRITISH COLUMBIA. See COLUMBIA, BRITISH.

BRITTANY, or BRITANNY (French, *Bretagne*), an ancient province and duchy of France, consisting of the north west peninsula, and nearly corresponding to the departments of Finistère, Côtes-du-Nord, Morbihan, Ille et Vilaine, and Lower Loire. It is popularly divided into Upper or Western, and Lower or Eastern Brittany. While it is not a mountainous country, none of the elevations much exceeding 1200 feet, it is remarkable for the extreme ruggedness of its physical features, especially along the coast and towards its seaward extremity. There are vast tracts of desolate moorland broken only by the melancholy monuments of a forgotten time, and gloomy water-courses worn deep into the stony strata. Elsewhere, however, beautiful valleys and romantic glens are traversed by full-flowing rivers. Agriculture is in general in a rather backward condition, though here and there there are signs of enterprise. Flax and hemp are largely grown; and in the more fertile districts excellent crops of the cereals are obtained. Bees are almost universally kept, and are often objects of a kind of affection. Pasture is abundant throughout the country, and the dairy produce forms a very important item in the food of the people. Industrial pursuits, except in a few seaport towns, which are rather French than Breton, have hitherto received but little attention. The Bretons are by nature conservative. They cling with almost equal attachment to their local customs and their religious superstitions. It was not till the 17th century that paganism was even nominally abolished in some parts, and there is probably no district in Europe where the popular Christianity has assimilated more from earlier creeds. Witchcraft and the influence of fairies are generally believed in, and charms and antidotes are trustfully resorted to. Part of this superstitious tendency may, no doubt, be attributed to the influence exerted on the minds of the people, not only by the strangeness of their natural environment, but also by the frequency of megalithic monuments, whose origin they cannot explain, for nowhere are these monuments so numerous and varied. The costume of both sexes is very peculiar both in cut and colour, but varies considerably in different districts. Bright red, violet, and blue are much used, not only by the women, but in the coats and waistcoats of the men. The reader will find full illustrations of the different styles in Bouet's *Breiz-izel ou Vie des Bretons de l'Armorique*, 3 vols., 1844. The Celtic language is still generally spoken, especially in lower Brittany, and a considerable body of traditional story and song is current among the people. Four dialects are pretty clearly marked. The whole duchy was formerly divided into nine bishoprics,—Rennes, Dol, Nantes, St Malo, and St Brieuc, in Upper Brittany; and Tréguier, Vannes, Quimper, and St Pol de Léon in Lower; and several of the larger towns were the seats of separate counts.

At the time of Cæsar's conquest of Gaul the north-western peninsula was inhabited by the Celtic tribes of the Veneti, the Curiosolitæ, and the Osismii; but our information in regard to them

is of the scantiest description. On the condition of this distinct, indeed, history is almost silent till the 5th century, when the invasion of Britain by the Saxons was followed by the migration across the channel of large numbers of the defeated islanders. The Breton chronicles contain an account of about a score of dukes from that period to the end of the 8th century; but how far the names and the narrative are merely mythical it would be hard to determine. The one great fact that is clearly evident is, that a violent contest for independence was maintained against the Frankish inroads. Under the early Carlovingians the country was for a time in rather more than nominal subjection; but it soon reasserted its independence. The 9th and 10th centuries are mainly remarkable for the wars that were continually breaking out between Brittany and the rising duchy of Normandy. Though Alan V. of Brittany had been intrusted with the guardianship of the youthful William of Normandy, and had fulfilled his trust to the full, yet under his successors Conan II., Hoel V., and Alan Fergent, the old enmity between the two countries broke out again and again. On the death in 1148 of Conan III., who had been defeated in a contest with his rebellious nobles, the succession was disputed by Hoel VI. and his brother-in-law, the count of Porhoet. The partizans of the former on their defeat submitted to Henry II. of England, who bestowed the



Map of Brittany.

duchy on his brother Geoffrey. Geoffrey's death two years after left the way open to the enterprise of Conan IV., grandson of Conan III., who had made his step-father prisoner, and was gradually obtaining possession of the whole duchy. The new duke, however, was forced not only to give his daughter Constance to Henry's son Geoffrey, but also in the long run to abdicate in his favour. On Geoffrey's death in 1186 the duchy became an object of dispute between the English and French kings, the latter being supported by the native nobility. To this rivalry the young duke Arthur fell a victim, murdered, as is usually supposed, by his uncle John of England. His sister Alice succeeded, under the protection of France, and was married to Pierre de Dreux, who thus became the first of a new line of dukes which lasted till the death of Francis II. in 1488. In 1491 the heiress Anne was forced to marry Charles VIII., and thus the duchy was held by the French crown. In 1532 it was formally united to France, but it retained a separate parliament till the Revolution.

Among the historians of Brittany may be mentioned Dom Lobineau, Dom Taillandier, Dom Morice, Daru, and De Courson. See also Trollope's *Summer in Brittany*, 1840; Mrs Bury Palliser, *Brittany and its Byeways*, 1869; Du Chatellier, *L'Agriculture et les classes agricoles de la Bretagne*, 1862.

BRITTON, the title of the earliest summary of the law of England in the French tongue, which purports to have been written by command of King Edward I. The origin and authorship of the work have been much disputed. It has been attributed to John le Breton, bishop of Hereford, on the authority of a passage found in some MSS. of the history of Matthew of Westminster; there are difficulties, however, involved in this theory, inasmuch as the bishop of Hereford died in 1275 (3 Edward I.), whereas allusions are made in Britton to several statutes passed after that time, and more particularly to the well-known statute "Quia emptores terrarum," which was passed in 18 Edward I. It was the opinion of Selden that the book derived its title from Henry de Bracton, the last of the chief justiciaries, whose name is sometimes spelled in the Fine Rolls Bratton and Bretton, and that it was a royal abridgment of Bracton's great work on the customs and laws of England, with the addition of certain subsequent statutes. The arrangement, however, of the two works is different, and but a small proportion of Bracton's work is incorporated in Britton. The work is entitled in an early MS. of the 14th century, which was once in the possession of Selden, and is now in the Cambridge University Library, "Summa de legibus Anglie que vocatur Bretone;" and it is described as "a book called Bretoun" in the will of Andrew Horn, the learned chamberlain of the city of London, who bequeathed it to the chamber of the Guildhall in 3 Edward III., together with another book called the *Mirroir des Justices*. Britton was first printed in London by Robert Redman, without a date, probably about the year 1530. Another edition of it was printed in 1640, corrected by Edmund Wingate. A third edition of it, with an English translation, has been lately published at the University Press, Oxford, 1865, by F. M. Nicholls, M.A. An English translation of the work without the Latin text had been previously published by R. Kelham in 1762.

BRITTON, JOHN, a topographical and antiquarian writer, was born at Kingston-St-Michael, near Chippenham, July 7, 1771. His birthplace, an old-world village of the dullest and sleepiest kind, had also the distinction of being the home of the antiquary John Aubrey. His parents were in humble circumstances, and he was left an orphan at an early age. He grew up with no better education than was to be had in the poor schools of his native Wiltshire village and neighbouring places, the last to which he was sent being at Chippenham. At the age of fourteen he became possessed of a small lot of books, and among them were *Robinson Crusoe*, the *Pilgrim's Progress*, and *The Life of Peter, Czar of Muscovy*. At sixteen he went to London,

and through the influence of a relative was apprenticed to a wine merchant. Prevented by failing health from serving his full six years, he found himself adrift in the world, without money, without friends, and without education. In his hand-to-hand fight with poverty he was put to strange shifts, becoming cellarman at a tavern and clerk to a lawyer, reciting and singing at a small theatre, and compiling a collection of common songs. During his apprenticeship he had read much in a loose, aimless manner; and gradually by successive small ventures he found his way into the broad paths of literature. A Salisbury publisher having projected a work on Wiltshire, invited Britton to undertake its preparation. The proposal was accepted; and in conjunction with his friend Edward Wedlake Brayley, Britton set himself to the task. Such was the small beginning of the voluminous work entitled *The Beauties of England and Wales*. The *Beauties of Wiltshire* appeared in two volumes in 1801, a third volume being added in 1825. The authors proceeded with other counties, and nine volumes of the entire series were their work. In the course of these early labours Britton's attention was especially drawn to antiquarian subjects; and thenceforth his proper field was before him, and in it he worked honourably. In 1805 appeared the first portion of his *Architectural Antiquities of Great Britain*, which extended to five volumes quarto, and was nine years in publication. On its completion Britton commenced his great work on the *Cathedral Antiquities of England*, the section on Salisbury Cathedral being the first published. It was completed in 1835, having been more than twenty years in progress, and forming altogether fourteen folio volumes. It is profusely illustrated by copperplate engravings.

As sole or joint author or editor Britton's name is attached to a large number of works of a like character. Among these may be mentioned the *Historical Account of Redcliffe Church, Bristol* (1813); *Illustrations of Fonthill Abbey* (1823); *Architectural Antiquities of Normandy*, with illustrations by Pugin, published in 1825–1827; *Picturesque Antiquities of English Cities* (1830); and the splendid *History of the Palace and Houses of Parliament at Westminster*, the joint work of Britton and Brayley, published in 1834–36. Mr Britton was a frequent contributor to the *Gentleman's Magazine* and other periodicals; he wrote the article "Shakespeare" for Rees's *Cyclopædia*, and the articles "Stonehenge," "Avebury," and "Tumulus" for the *Penny Cyclopædia*. In his later years he began to write his Autobiography, but did not carry the personal narrative far. The portion published is rich in literary anecdote of the times. Britton died in London, January 1, 1857, and his remains were interred in Norwood Cemetery. A *Descriptive Account of his Literary Works* was published by his assistant T. E. Jones. Britton was the originator of a new class of literary works. "Before his time," says Mr Digby Wyatt, "popular topography was unknown." He first combined antiquarian with topographical description. He effected a great improvement in the style and character of the illustrations of ancient monuments; and the general admiration excited by the engravings in his works gave rise to a novel interest in his subject, and became one of the incitements to deeper studies and investigations.

BRIVES-LA-GAILLARDE, a town of France, capital of an arrondissement in the department of Corrèze, situated in a beautiful and fertile plain twenty miles from Tulle. It is surrounded with elm-planted boulevards, and possesses a number of well-preserved houses of an early date. None of its public buildings (which comprise several churches, a theological seminary, and a college) are of much importance, except the church of St Martin, dating from the 13th century. The town carries on an active trade in cattle, wool, wine, oil, and grain, manufactures wax candles, copperwares, and cotton thread, and has millstone and slate quarries. Brives is of ancient origin, and for a long time disputed the title of capital of the Lower Limousin with the city of Tulle. It was the birthplace of the Cardinal Dubois. Population in 1872, 8417.

BRIXEN, a town of Austria in Tyrol, situated in the Pusterthal at the confluence of the Eisack and Rientz, in 40° 40′ N. lat. and 11° 37′ E. long., 104 miles from Vienna by rail. It is the seat of a bishop, and has a cathedral built in the 18th century, a theological seminary, a gymnasium, and several monasteries. There are iron and steel factories in the neighbourhood, and the baths of Maria-Louisa are supplied with water from a chalybeate spring. About nine miles from the town is the great fort of Franzensfeste, built in 1838, at the junction of the roads from Botzen, Innsbruck, and Pusterthal. Brixen (in Italian *Bressanone*) is mentioned at least as early as 901. In 1025 it became the seat of a bishop, and in 1038 was surrounded with walls. In 1174, 1234, and 1445 it was destroyed by fire; in 1519 it was stormed by the French under Gaston de Foix; and in 1525 it suffered from the rebellion of the peasants. Population in 1869, 4349.

BRIXHAM, a seaport town of England, in the county of Devon, about 200 miles from London, with a station about two miles distant on the South Devon Railway. The town is irregularly built on the cliffs to the south of Torbay, and its harbour is defended by a modern breakwater. It carries on a very extensive fishing and coasting trade, and is a place of resort for sea-bathing. In the early part of the present century it was the seat of a considerable military establishment, with fortified barracks at Bury Head, and it is celebrated in history as the spot where King William landed in 1688. Population of the parish in 1871, 6542.

BROACH, or BHARUCH, a district of British India under the jurisdiction of the governor of Bombay, extending from 21° 22′ to 22° 11′ N. lat. and from 72° 30′ to 73° 10′ E. long. It is bounded on the N. by the River Máhi, on the E. and S. by the territory of the Gaikwar, and on the W. by the Gulf of Cambay. Consisting chiefly of the alluvial plain at the mouth of the River Nerbudda, the land is rich and highly cultivated, and though it is without forests it is not wanting in trees. The district is well supplied with rivers, having in addition to the Nerbudda, the Mahi in the north and the Kíni in the south. The area is 1320 square miles; the population 350,322, of whom 248,343 are Hindus, 69,033 Mahometans, 3986 Buddhists, 3116 Pársís, and 24,703 belong to the aboriginal tribes. The population comprises several distinct races or castes, who, while speaking a common dialect, Gujaráthi, inhabit separate villages. Thus there are Koli Kembi or Voro (Borah) villages, and others whose lands are almost entirely held and cultivated by high castes, such as Rájputs, Bráhmans, or Pársís.

Except in the city of Broach, which has two steam ginning factories and a considerable general trade, agriculture is almost the sole industry of the district. The export of cotton, the principal agricultural product, amounted in 1872 to 88,471 bales. The most important cereal and pulse corps are—for the rains, jawári (*Holcus Sorghum*) rice, bágri (*Pencillaria spicata*), túr (*Cajanus indicus*), and múg (*Phaseolus Mungo*); and for the cold weather, wheat, til (*Sesamum indicum*), pea, gram (*Cicer arietinum*), wal (*Lablab vulgaris*), castor oil, and tobacco. The total revenue of the district amounted in 1872 to £318,972, of which £266,936 was imperial land revenue; £20,568 on account of the local land cess; stamps yielded £22,714; excise, £6823; and assessed taxes, £193. The imperial expenditure in the district amounted during the same time to £72,025. Of the whole area of the district, viz., 1320 square miles, 72 per cent. are returned as cultivated, 3 per cent. cultivable but not actually under tillage, and 25 per cent., including the sites of villages, river-beds, &c., as uncultivable. There are five towns with a population of over 5000 inhabitants,—Broach, 36,932; Jambusar, 14,924; Ankleswar, 9414; Amod, 6125; and Gajera, 5239. In the first two of these towns municipalities have been established. The district contains 191 schools, with an attendance of 6525 scholars. The total number of persons receiving or who have received some education amounts to 9·5 per cent. of the enitre population. The strength of the district police force is 415, giving to each man the charge of three square miles and 844 inhabitants. The principal criminal class is the Bhils, numbering about 24,000. The difficulty of arresting offenders of this race is increased by the fact that they are in league with members of their tribe in the native states of Baroda and Rájpipla, and can therefore with ease escape into foreign territory.

Broach, the principal place of the district of the same name, situated on an elevated mound, supposed to be artificial, on the northern bank of the Nerbudda, about 30 miles above its mouth, in 21° 42′ N. lat. and 73° 2′ E. long. The river is here a noble sheet of water, two miles wide at ebb tide, but shallow for the most part even at flood-tide, though there is then a deep but intricate channel admitting vessels of considerable burden. In 1872 the population of the town and municipality was returned at 36,932. As in the generality of eastern towns, the streets are narrow and the houses lofty. It has a considerable trade, and annually exports large quantities of raw cotton to Bombay. Broach is thought with some appearance of probability to have been the Barygaza of Ptolemy and Arrian. Upon the conquest of Guzerat by the Mahometans, and the formation of the state of that name, Broach formed part of the new kingdom. On its overthrow by Akbar in 1572, it was annexed to the Mughul empire and governed by a Nawáb. The Marhattás became its masters in 1685, from which period it was held in subordination to the Peshwá until 1772, when it was captured by a force under General Wedderburn (brother to Lord Loughborough), who was killed in the assault. In 1783 it was ceded by the British to Sindhiá in acknowledgment of certain services. It was stormed in 1803 by a detachment commanded by Colonel Woodington, and was finally ceded to the East India Company by Sindhiá under the treaty of Serji Anjangáon. Distance north from Bombay 190 miles.

BROADSTAIRS, a town of England, in the county of Kent, about a mile and a half to the south of the North Foreland, and three miles from Margate, on the London, Chatham, and Dover Railway. It has a small pier for fishing-boats—built in the reign of Henry VIII., a modern Gothic church, hotels, libraries, and bathing-establishments; and in the summer season it attracts a considerable number of visitors. There is an archway leading down to the shore, which bears that it was erected by George Culmer in 1540, and not far off is the site of a chapel of the Virgin, to which ships were accustomed to veil their top-sails as they passed. Population in 1871, 1926.

BROCCHI, Giovanni Battista, a celebrated Italian mineralogist and geologist, was born at Bassano, in February 1772. He studied at the university of Pisa, where his attention was especially turned to mineralogy and botany. In 1802 he was appointed professor of botany in the new Lyceum of Brescia; but he more particularly devoted himself to geological researches in the numerous excursions he made into the adjacent districts. The fruits of these labours appeared in different publications, particularly in his *Treatise on the Iron Mines in the department of Mella;* and his *Essay on the Physical Constitution of the Metalliferous Mountains of the Valley of Trompia,* which appeared in 1807. His valuable researches procured him, in the following year, the office of inspector of mines in the recently established kingdom of Italy, which enabled him to extend his investigations over a great part of Central and Southern Italy, as well as its northern districts. In 1811 he produced a valuable memoir *On the Mineralogy of the Valley of Fassa and the Tyrol,* but his most important work is the great *Geologie Fossile Subapennina con Osservazioni Geologiche sulle Apennini, e sul Suolo Adjacente,* 2 vols. 4to, Milan, 1814, containing most accurate details of the structure of the Apennine range, and an account of the fossils of their strata. These subjects were further illustrated by his valuable geognostic map and his *Catalogo ragionato di una Raccolta di Rocche, disposto con ordine Geografico, per servire d'Illustrazione della Carta Geognostica dell' Italia,* Milan, 1817. His work, *Dello Stato Fisico del Suolo di Roma,* with its accompanying map, is admirable for accuracy and judgment. In it he has corrected the erroneous views of Breislak, who conceived that the Eternal City occupies the site of a volcano, to which he ascribed the tufa and other volcanic materials that cover the seven hills. Brocchi, on the other hand, has satisfactorily shown that they are derived either from Mont Albano, an extinct volcano, 12 miles from Rome, or from Mont Cimini, still further to the north of the city. Indeed he has shown that the streams or beds of tufa may be traced almost uninterruptedly from that mountain to Rome. Several minor papers by him, on other mineralogical subjects, appeared in the *Biblioteca Italiana* from 1816 to 1823. In the latter year Brocchi sailed for Egypt, and engaged with his usual ardour in exploring the geology of that country and its mineral resources, every facility being granted by Mehemet Ali, who in 1825 appointed Brocchi one of a commission to examine and organize his conquest of Sennaar, but the naturalist, unfortunately for science, fell a victim to the climate, at Khartum, in September 1826.

BROCKHAUS, Friedrich Arnold, an eminent German publisher, was born in Dortmund, on the 4th May 1772. He was educated at the gymnasium of his native place, and from 1788 to 1793 served an apprenticeship in a mercantile house at Düsseldorf. He then devoted two years at Leipsic to the study of modern languages and literature, after which he set up at Dortmund an emporium for English goods. In 1810 he transferred this business to Arnheim, and in the following year to Amsterdam. In 1805, having given up his first line of trade, he, in conjunction with a friend, began business as a publisher. Two journals projected by him were not suffered by the Government to survive for any length of time, and in 1810 the complications in the affairs of Holland induced him to return homewards. In 1811 he settled at Altenburg. About three years previously he had purchased the copyright of the *Conversations-Lexicon,* which had been begun in 1796, and in 1810–11 he completed the first edition of this celebrated work. A second edition under his own editorship was begun in 1812, and was received with universal favour. His business expanded rapidly, and in 1817 he removed to Leipsic, where he established a large printing-house. Among the more extensive of his many literary undertakings were the critical periodicals—*Hermes,* the *Literarische Conversationsblatt* (afterwards the *Blätter für literarische Unterhaltung*), and the *Zeitgenossen,* and some large historical and bibliographical works, such as Von Raumer's *Geschichte der Hohenstaufen,* and Ebert's *Allgem. Bibliographis. Lexicon.* The work distinctively associated with his name, and with the publishing house which has been carried on by his sons, is the *Conversations-Lexicon,* in many ways the completest and best encyclopædia of its kind, which has now reached its twelfth edition. Brockhaus died in 1823.

BROCKLESBY, Richard, a physician of considerable reputation, was born in Somersetshire, 11th August 1722. He was educated at Ballytore, in Ireland, studied medicine at Edinburgh, and finally graduated at Leyden in 1745. In 1751 he was admitted a licentiate of the Royal College of Physicians at London, of which he afterwards became a fellow. In 1758 he was appointed physician to the army, in which capacity he served in Germany during the greater part of the Seven Years' War, and in the course of it was chosen physician to the hospitals for British forces. The results of his observations during this period were published in 1764, under the title of *Economical and Medical Observations from 1758 to 1763, tending to the Improvement of Medical Hospitals.* He had already given many proofs of his industry and his attainments by papers published in the *Transactions of the Royal Society.* His *Dissertation on the*

Music of the Ancients appeared in 1749, and his *Oratio Harveiana* in 1760. Shortly after this he was appointed by the duke of Richmond physician-general to the royal regiment of artillery and corps of engineers, an appointment that gave him constant access to the laboratory of Woolwich, and it was by his advice that a professorship of chemistry was added to the establishment of the college. In his latter years he withdrew altogether into private life. The circle of his friends included some of the most distinguished literary men of the age. His intimacy with Burke had commenced at school, and soon ripened into the warmest friendship. He was also warmly attached to Dr Johnson, to whom he offered an annuity of £100 during the remainder of his life to enable him to visit the Continent for the recovery of his health; and when this offer was declined, he pressed him to reside in his house, as more suited to his health than that in which he then lived. He attended the great moralist on his deathbed. The same generous disposition was manifested in his conduct to Burke, to whom he presented £1000, a sum he had intended to leave him by will. Dr Brocklesby died suddenly 11th December 1797. He left his entire fortune, with the exception of a few legacies, to his two nephews, Dr Thomas Young and Mr Beeby.

BRODERIP, William John, a distinguished writer on natural history, was born in Bristol, probably in 1787. He was educated at the school conducted by the Rev. Samuel Seyer, and proceeded to Oriel College, Oxford, where he began the study of law. He was called to the bar in 1817, and took part for several years in editing the law reports. In 1822 he was appointed by Sir Robert Peel one of the metropolitan police magistrates, a post which he occupied for thirty-four years. All his leisure time was devoted to the favourite study of his earlier days—natural history. He was a member of most of the scientific societies, contributed numerous papers to their Transactions, and did much to further the study of zoology in England. He acted for many years as vice-president of the Zoological Society. The zoological articles in the *Penny Cyclopædia* were written by him, and made him widely known as an original investigator and able expositor. A series of articles contributed to *Fraser's Magazine* were reprinted in 1848 as *Zoological Recreations*, and were followed in 1852 by *Leaves from the Note-Book of a Naturalist*. Broderip died on the 27th February 1859.

BRODIE, Sir Benjamin Collins, Bart., a distinguished physiologist and surgeon, was born in 1783 at Winterslow, county of Wilts, and died at Broome Park, 21st October 1862, in the 79th year of his age. His paternal grandfather, connected with the family of Brodie of Brodie, was born in Banffshire about the year 1710, and came as an adventurer to London, where he acquired considerable wealth as an army clothier. One of his sons, the father of the subject of this notice, was educated at the Charter House, and afterwards at Worcester College, Oxford, where he took holy orders. Here he probably acquired the friendship of the first Lord Holland, with whom he afterwards lived at Holland House. The second Lord Holland having purchased the estate of Winterslow, Mr Brodie rented a cottage near the same place. The second Lord Holland died in 1774, and directed in his will that Mr Brodie should have offered to him the presentation of the first of three livings which he had in his gift when a vacancy occurred. This event took place in consequence of the death of the incumbent of Winterslow, and Mr Brodie became rector of the parish. In 1775 he married one of the daughters of Mr Collins of Milford, a banker of Salisbury. They had six children,—four sons and two daughters,—and the subject of this sketch was their fourth child.

He received his early education from his father, who appears to have been a man of energy, ability, and method; and at an early age he had acquired a considerable knowledge of the classics. When the time for choosing a profession arrived, his father intimated to him that he was intended for that of medicine, and accordingly, in the autumn of 1801, he began to attend the anatomical lectures of the celebrated Abernethy in London. As his family was connected by marriage with several of the leading members of the profession, such as Dr Denman (the father of the first Lord Denman), Dr Baillie, and Sir Richard Croft, the young student enjoyed many advantages of distinguished professional society, but it does not appear that at this period of his life he had any predilection for medical studies or any aptitude for surgical work. The great eminence as an operator to which he afterwards attained was gained, as he himself said, by persistent application and perseverance.

He devoted great attention to the clinical study of disease, and began to make an elaborate series of notes of cases which came under his observation. This habit he continued throughout life, and thus gradually amassed that enormous amount of practical experience which afterwards gave his advice as a consulting surgeon such weight.

Like most young adventurers in the fields of science of that day, he early began to teach. He gave many courses of lectures upon anatomy, not only as it bore on surgical practice, but as a science having important physiological and teleological relations. In 1808 he became assistant-surgeon to St George's Hospital, and he continued on the staff of that institution for over thirty years. This gave him the opportunity of teaching clinically, and he soon acquired a reputation as an able and fluent extempore speaker. In 1810 he was elected a fellow of the Royal Society, and in the following year communicated a series of papers "On the Influence of the Brain on the Action of the Heart, and on the Generation of Animal Heat." In 1812 he also communicated a paper "On the Mode in which Death is produced by certain Poisons." These papers were founded upon a series of careful physiological experiments, having for their object to determine, first, the relation of the nervous system to the circulatory and nutritive systems in higher animals, and, second, to ascertain, if possible, how poisons produce death. The most important fact ascertained by the first series of experiments was that the stoppage of the heart's action at the moment of death does not depend on the removal of the influence of the brain, but on the arrest of respiration. He also pointed out some important facts which could only be accounted for by supposing that the nervous system has an influence on the production and diffusion of animal heat, an idea not then generally accepted. For these researches he received the Copley medal of the Royal Society in 1811. In 1813 he delivered the Croonian lecture, "On the Effect of the Nerves on the Heart and on the Involuntary Muscles," and in 1814 he contributed another paper "On the Influence of the Nerves of the Eighth Pair on the Secretions of the Stomach." In 1816 he performed many experiments on animals, to ascertain the influence of bile on the food during its passage through the bowels. These papers comprehend what Brodie accomplished in physiology. They are all characterized by lucidity, conciseness, sound judgment, and a modest interpretation of results. They are valuable at the present time not so much for the facts they contain, most of which are now incorporated in the general mass of scientific knowledge, but as admirable illustrations of the application of the experimental method of research to physiological questions.

At this period of his career Brodie rapidly glided into a large and lucrative practice, and more especially he quickly gave evidence of superior powers as an operator, having

knowledge, coolness, and readiness of resource. From time to time he wrote upon surgical questions, contributing numerous papers to the *Transactions of the Royal Medical and Chirurgical Society*, and to the medical journals. Probably his most important work is that entitled *Pathological and Surgical Observations on the Diseases of the Joints*, in which he attempts to trace the commencements of disease in the different tissues which form a joint, and to give an exact value to the symptom of pain as evidence of organic disease. The thoughts suggested by this volume led to the adoption by surgeons of measures of a conservative nature in the treatment of diseases of the joints, by which the number of amputations has been reduced, and many limbs and lives have been saved. He also wrote on diseases of the urinary organs, and on local nervous affections of a surgical character. Brodie was a man of restless activity; to use his own words, he felt "his happiness to be in a life of *exertion*." When released from professional cares he had recourse to literary and scientific pursuits, and especially to the study of psychological questions. He was fond of reading, collecting facts, and speculating on all matters connected with mental phenomena; and in 1854 he published anonymously a work entitled *Psychological Inquiries—the First Part*. A second edition of this work appeared in 1855, a third in 1856, a fourth in 1862, and in the same year the *Second Part* was also published. This work enjoyed well-merited popularity, as it was written in clear untechnical language, and revealed the speculations of the writer concerning the mind of man. When the name of the author became known, the greatest interest was excited in the work, although it contains nothing new to professed psychologists. He wrote also occasionally for the quarterly reviews.

Brodie received many honours during his career. He was the medical adviser of three successive sovereigns, and in 1834 he was elevated to the rank of a baronet. It is generally believed that he might have been created a peer had he desired the honour. He became a corresponding member of the French Institute in 1844, D.C.L. of Oxford in 1855, and president of the Royal Society in 1858; and he was the first president of the Medical Council under the Act for the Education and Registration of the Medical Profession.

A complete edition of his works, with an autobiography, in three volumes, appeared in 1865, collected and arranged by Charles Hawkins, fellow of the Royal College of Surgeons of England; and a generous and discriminative biographical sketch, by Professor Henry W. Acland of Oxford, appeared in the obituary notices in the *Proceedings of the Royal Society* for 1863. (J. G. M.)

BRODY, a town of Austria, in the circle of Zloczow, in Galicia, near the Russian frontier. It contains three large synagogues, a Jewish hospital, and a Jewish college, and from its prevailing Jewish character has been called the German Jerusalem. There are also one Roman Catholic and three Greek churches and an industrial school. Its castle is the residence of the Counts Potocki. It is the seat of an extensive trade carried on with Russia and Turkey, and has two large annual fairs, the principal articles of sale being wool, cotton, silk, and peltry. In 1869 the population, of which about two-thirds are Jews, amounted to 18,890. Brody was founded in 1679 under the name of Lubicz, and was raised to the rank of a free commercial city in 1779.

BROGLIE, Achille Léonce Victor Charles, Duc de, peer of France, was born in Paris 28th November 1785, and died 25th January 1870. The family from which this eminent statesman descended was of Piedmontese origin, but it won its honour in the service of France. The first Marshal de Broglie (1639–1727) served with distinction under Louis XIV.; his son, known as the Chevalier de Broglie (1671–1745), was raised to the highest grade in the French peerage for his gallant military service at Guastalla and at Prague in 1742, but he refused the rank of marshal of France, which was offered to him by the regent, on the ground that his father, who was still alive, deserved it more than he did. The next in descent was the second marshal (1718–1804), who commanded the French armies in the Seven Years' War, for which he was created a prince of the empire, and though subsequently disgraced and exiled by the intrigues of the Condés, he was recalled in 1789 by Louis XVI. to the office of commander-in-chief. To stem the tide of the Revolution was impossible. The marshal speedily fell from power, emigrated to Germany, refused the solicitation of Napoleon to return to France, and died at Münster in 1804.

The son of this veteran followed an opposite course and met with a more untimely end. He adopted the liberal opinions of the time. He followed Lafayette and Rochambeau to America. He sat in the Constituent Assembly, constantly voting on the Liberal side. He served as chief of the staff to the Republican army on the Rhine; but, like many other champions of the Revolution, he was denounced, arrested, dragged to Paris, and executed on the 27th June 1794. The parting injunction he left to his son, Victor de Broglie, the subject of this notice, then a boy nine years old, was ever to remain faithful to the cause of liberty, even though it were ungrateful and unjust. His father murdered, his mother imprisoned, his property confiscated and plundered, the young de Broglie first appears in life in wooden shoes and a red cap of liberty, begging an assignat from the younger Robespierre. Yet he adhered to the cause for which his father had died; he maintained through life the principles of 1789. He seemed to have forgotten his own rank, until he was reminded of it at the Restoration by a writ of summons to the Chamber of Peers, and in early life he served, not unwillingly, as one of the officers of the council of state of the emperor Napoleon I.

In 1815, before he had completed his 30th year, the Duc de Broglie was summoned by Louis XVIII. to the Chamber of Peers. He combined, in a manner rare in France, the qualities we are wont to respect in the most eminent members of the British aristocracy,—high rank, independent fortune, unblemished integrity, unflinching patriotism, and a sincere and consistent attachment to liberal opinions. The first incident in his parliamentary life was the trial of Marshal Ney, and on this occasion he had the courage to speak and vote alone for the acquittal of the prisoner, on the ground that he was not guilty of deliberate treason; no other peer of France supported his protest on that occasion. During the Restoration he continued to take an active part in the defence of liberal opinions and measures. He refused to take office in the cabinet of M. de Serre. He opposed the reactionary policy of the court. He supported the short-lived administration of M. de Martignac, and he acted with the party known as the *doctrinaires*, of which M. Royer-Collard was the founder, and M. Guizot the ablest representative. Meanwhile, in 1816, he had married the daughter of Madame de Stael, a union of unbroken domestic happiness; and he had pledged himself to that sacred cause of Negro emancipation, in which he was the worthy rival and ally of Clarkson, Buxton, Wilberforce, and Brougham. The revolution of July 1830 imposed fresh duties on the Duc de Broglie. Though reluctant to take office from his cold, retiring, and unambitious temperament, he consented to hold the ministry of public worship in the first cabinet of Louis Philippe's reign, and in 1832, after the death of Casimir Périer, he was prevailed upon to take the more important department of foreign affairs. In this function he

strengthened the alliance of France with England; he negotiated the Quadruple alliance; he contributed to the settlement of the Belgian and Greek questions; and he laboured with success to preserve the peace of Europe. He was out of office from March 1834 to March 1835, but he returned to power at the latter date, and this time as the head of the cabinet. He was riding by the side of the king when Fieschi's "infernal machine" was fired on the royal cortege, and a bullet passed through the collar of his coat. In 1836 the Government was beaten on the question of the reduction of the five per cents., and M. de Broglie retired permanently from official life. The king, it must be said, had never found in him a congenial minister. His manner was dry and somewhat harsh, his character unbending, and for the remainder of the reign of Louis Philippe, M. de Broglie, though not in opposition, was the censor rather than the servant of the crown. With M. Guizot, though not in office, he preserved through life the relations of the closest personal friendship and political union. The overthrow of the constitutional monarchy in 1848 was a heavy blow to this parliamentary veteran, for he felt that the form and system of government to which he was most attached were at an end for ever. He consented, however, from patriotic motives to sit in the republican assemblies of 1848, and as a member of the section known as the "Burgraves" he laboured to counteract some of the evils of universal suffrage, and to avert the catastrophe which he saw to be impending over France. He shared with his colleagues the indignity of the *coup d'état* of December 2, 1851, and remained for the remainder of his life one of the bitterest enemies of the imperial régime, although he has been heard to remark with that caustic wit for which he was famous, that the empire was "the government which the poorer classes in France desired and the rich deserved." The last twenty years of his life were devoted chiefly to philosophical and literary pursuits. Having been brought up by his step-father, M. d'Argenson, in the sceptical opinions of the time, he gradually arrived, by study and reflection, at a full and sincere belief in the truth of the Christian religion. "I shall die," said he, a "penitent Christian and an impenitent Liberal." His literary works, though few of them have been published, were rewarded by a seat in the French Academy, and he was also a member of another branch of the French Institute, the Academy of Moral and Political Science. In the labours of those learned bodies he took an active and assiduous part; and on his death, which took place at the advanced age of 85, just before the lamentable events of 1870, he was followed to the grave by representatives of all that is most illustrious in the political and literary society of France, revered as one of the wisest and most upright men of his age. He was succeeded in the honours of his house by Albert de Broglie, his eldest son, also distinguished by his literary works, and who has since 1871 played no inconsiderable part in the political affairs of his country as a leading member of the National Assembly, and for sometime head of the cabinet of Marshal Macmahon. (H. R.)

BROKER, a word derived variously from the French *broier*, to grind, and *brocarder*, to cavil or higgle. and the Saxon *broc*, misfortune.

A broker is an agent or intermediate person appointed for transacting special business on account of another, but differing somewhat from an ordinary factor in functions and responsibility. Of this class there are various descriptions, exercising employment without the smallest analogy, though all are brought under the general name of brokers: of these the principal are—exchange brokers, whose province is to ascertain the rates and relation of exchange between countries; stock-brokers, who negotiate transactions in the public funds; insurance brokers, who effect insurances on lives or property; and pawnbrokers, who advance money on goods, on the condition of being allowed to sell the goods if the sum advanced is not repaid with interest within a limited time. See AGENT and INSURANCE.

Separating pawnbrokers, and those dealers in old wares who are called brokers, as both distinct from the class to whom the term in its broader acceptation applies, the broker is an agent for both parties, the buyer and the seller; and for the general principles of jurisprudence applicable to his position, reference may be made to the article AGENT. It is a marked peculiarity, however, of the broker as an agent, that his quality of agency is not only palpable in the face of the transactions, but he is agent for both parties. The function of the broker is indeed a very simple one, and easily separates itself from the usual intricacies of the law of sale and of agency. It is his proper function to find buyers and sellers, and to bring them together that they may transact with each other. Hence the rise of such a class in any department of business is an indication of its great increase. In small towns, and in narrow and peculiar departments of business, the buyers and the sellers know each other, and need not be at the expense of employing a third party. But where both bodies are numerous, and the individual members of each find enough to occupy their attention in the production of their commodity, or its purchase and distribution, there is economy in the establishment of a distinct class who bring the buyer and the seller together. The broker usually gives what are called bought and sold notes to his clients, and some nice questions have arisen as to the effect of these when they do not correspond with each other or with the entry in the broker's books. The amount of broker's commission is in some few cases fixed by statute,—*e.g.*, under 10 Anne c. 19, § 120, a fine of £20 is imposed on brokers charging more than 2s. 9d. per cent. for buying or selling tallies, exchequer tickets, bank bills, &c. Generally it is settled by agreement with the principals or by the custom of trade. The brokers for the purchase and sale of goods within the city of London are a body with peculiar privileges, and acting under special licensing regulations, some of which date back to the reign of Henry VIII. The London Brokers' Relief Act (1870) has considerably altered their position, but they must still be admitted by the court of mayor and aldermen, and the penalty of £100 for acting as a broker without qualification may still be imposed. A list of London brokers is kept by the mayor and aldermen; and if a broker has been convicted of felony or fraud, or certified by a superior judge to have been guilty of fraud, he may be absolutely or for a time disqualified. There has been some doubt as to the class of persons falling under these regulations; ship-brokers and auctioneers, it would appear, do not.

BROMBERG, a town of Prussia, capital of a government in the province of Posen, is situated 70 miles north of the city of that name on the River Brahe, which is there crossed by a fine new railway bridge. Its public buildings comprise two Roman Catholic churches, a Protestant church, and a Jewish synagogue, a gymnasium, a seminary, a workhouse and penitentiary, a hospital, and a military storehouse. It has large mills, manufactures linen and woollen stuffs, leather, tobacco, Prussian blue, sugar, chicory, vinegar, beer, brandy, and oil, and carries on an active transit trade. The Bromberg Canal, constructed in 1773–4 by command of Frederick II., at a cost of 700,000 dollars, connects the Brahe with the Netz, and thus establishes communication between the Vistula, the Oder, and the Elbe. Bromberg is mentioned as early as 1252. From 1327 to 1343 it was in the hands of the Teutonic Order.

Destroyed in war it was restored by Casimir of Poland in 1346, and down to the close of the 16th century it continued to be a flourishing commercial city. It afterwards suffered so much from war and pestilence that about 1772, when the Prussians took possession, it contained only from five to six hundred inhabitants. By the treaty of Tilsit it was transferred to the duchy of Warsaw; in 1813 it was occupied by the Russians, and in 1815 it was restored to Prussia. Population in 1871, 27,740.

BROME, ALEXANDER, a minor English poet, was born in 1620, and died in 1666. He was an attorney in the lord mayor's court, and was the author of many of the songs and epigrams that were published in favour of the Royalists and against the Rump. These, together with his epistles and epigrams, translated from different authors, were all printed in one volume, octavo, after the Restoration. He published a translation of Horace by himself and others, and was the author of a comedy entitled *The Cunning Lovers*. He also edited two volumes of Richard Brome's plays.

BROME, RICHARD, a dramatic writer in the reign of Charles I., and a contemporary of Dekker, Ford, Shirley, and others. He was originally a servant of Ben Jonson; but he soon acquired a high literary reputation, and was addressed in some lines by his quondam master on account of his comedy entitled *The Northern Lass*. Brome's genius lay entirely in comedy. His plots are original and well managed, and his characters, which for the most part are strongly marked, were drawn from his own experience. He has left fifteen comedies. See Ward's *English Dramatic Literature*, 1875, vol. ii., for a good notice of Brome.

BROMINE, one of the halogen group of non-metallic chemical elements, which comprises three other members,—chlorine, iodine, and fluorine. The whole group has many properties in common, the most marked being their behaviour towards hydrogen, uniting with it atom for atom, forming gaseous condensible acid compounds, which are all produced by similar reactions, and which yield in combination with metals crystals of uniform structure. Bromine was discovered in 1826 by Balard, who extracted it from the water of the Mediterranean during his researches in connection with the sea-water. At ordinary temperatures it is a deep brownish-red liquid, emitting a strong disagreeable odour (whence its name, from βρῶμος, a stink), having a specific gravity of 2·96, freezing into a red-brown crystalline mass at $-24·5°$ C., and boiling at 63° C. Its combining equivalent or atomic weight is 80. Bromine is an element of great chemical activity, and of the highest interest in scientific chemistry on account of its combinations, and especially on account of the products of its substitution for hydrogen in organic compounds.

Although very widely disseminated, since it is found in ocean water, bromine is nowhere an abundant element. It is a constituent of some silver ores from Mexico and South America; it is very generally found in strong saline springs, as well as associated with deposits of salt; and it is present in many marine plants. The waters of the Atlantic, according to Von Bibra, contain 24 grains per gallon; while Herepath's analysis gives Dead Sea water a strength of 121·5 grains per gallon. It is only from the waters of certain saline springs in America that bromine is prepared as a direct product. At several places in western Pennsylvania and West Virginia the manufacture is carried on extensively, 125,000 lb having been extracted in 1870. In Europe bromine is only obtained as a secondary product of the preparation of potash and other alkaline salts, its chief source being the mother-liquors of the kelp manufacture, brine springs, and especially the Stassfurth saline deposits, near Magdeburg, Prussia. The produce at Stassfurth in 1873 amounted to about 10,000 lb; and it is estimated that the yield of English and French works was, taken together, about the same.

On the commercial scale bromine is prepared at Stassfurth from the liquids which have been exhausted of all their crystallizable soda and potash salts, and from which also a deposit of chloride of magnesium has been obtained. This final mother-liquor is found to contain from 0·3 to 0·5 per cent. of bromine, in the form of bromide of potassium. To separate the bromine the liquor is introduced into a sandstone apparatus similar to that used for the evolution of chlorine from common salt,—the process and reaction being similar in both cases. In this it is mixed with black oxide of manganese and sulphuric acid in definite proportions, and heated by a current of steam. The red vapour of bromine is given off and led by a pipe into a condensing worm of earthenware, and received into a series of three Woulfe's bottles, the first of which contains water, and the others alkaline ley and iron filings. The reaction which takes place is thus represented—

$$2KBr + MnO_2 + 3H_2SO_4$$
$$= 2KHSO_4 + MnSO_4 + 2H_2O + 2Br,$$

—sulphates of potash and manganese, water, and free bromine being produced from bromide of potassium, manganese dioxide, and sulphuric acid. Pure bromine vapour distils over at first, but as the distillation proceeds chlorine is gradually evolved, and from this the bromine may be freed by shaking up with a solution of bromide of potassium, which yields up its bromine to combine with chlorine. On account of its peculiarly irritating action on the organs of respiration, very great precautions have to be taken to protect workmen from the fumes of bromine, and it is indispensable that those engaged in the industry should abstain from all alcoholic liquors.

The chief industrial application of bromine and its compounds is in medicine, for which it is used in the form of bromide of potassium, bromide of ammonium, and bromide of sodium, besides in various combinations with alkaloids and organic substances. It is, however, most largely employed as bromide of potassium, a salt prepared on the large scale by the decomposition of potassium carbonate by the bromide of iron. It is also prepared by passing the vapour of bromine into a solution of caustic potash, when a mixture of bromide and bromate of potassium is produced. The mixed salts are reduced to a uniform bromide by burning with coal dust. Bromide of silver is employed to some extent in photography, and, according to the experiments of Vogel, it possesses a peculiar sensitiveness for the red, green, and yellow colours, which are not acted on by other photographic agents. During the American Civil War (1861–5) bromine came into use as a disinfectant in military hospitals, a purpose to which it was also applied in the Franco-German War in 1870–1. For such purposes it was found to possess several advantages over chlorine, which, however, has the recommendation of cheapness and abundance. It has long been hoped that bromine might be substituted for iodine in the preparation of the several coal-tar colours, but hitherto the attempts in that direction have not been successful. Eosine, a tetrabromated potassium salt, is the only dye into which bromine at present enters. The use of bromine has been suggested by Dr Rudolf Wagner in several metallurgical operations, in which he anticipates it might be of great service. He proposes, in place of the present wasteful method of reducing mercury from cinnabar, to digest the ore in an aqueous solution of bromine, whereby a bromide of mercury would be formed. He also suggests that bromine might be advantageously applied to the extraction of gold from poor auriferous ore, in a manner analogous to Plattner's chlorination process. Further, it is recom-

mended for the refining of gold by the formation of a bromide; and it is thought that bromine vapour might be used with advantage for toughening brittle gold.

BROMLEY, a market-town of England, in the county of Kent, 10 miles S.E. of London. It is situated on high ground to the north of the river Ravensbourne, and since the opening of the railway has become a favourite residence for men of business from London. It has a town-hall—built in 1864, an old market-house, a literary institution, and a college, originally founded in 1666 by Bishop Warner for the residence and support of clergymen's widows. The church is a fine Gothic building, containing some handsome monuments; and in the vicinity is a palace, erected in 1777 in room of an older structure, for the bishops of Rochester, to whom the manor has belonged since the time of Ethelbert. In the gardens attached is a mineral spring known as St Blaze's Well, which was in great repute before the Reformation. The population of the parish, which in 1861 was only 5505, amounted at the census of 1871 to 10,674. The parish includes the villages of Plaistow, Sundridge, Bickley, Widmore, Elmstead, Southboro', and Bromley Common.

BROMSGROVE, a market-town of England, in the county of Worcester, 13 miles S. by W. of Birmingham, with a station on the Birmingham and Worcester Railway, at the distance of a mile and a half. The church of St John is a fine old building, restored in 1858, with a tower and spire 189 feet in height. The free grammar school, founded by Edward VI., has been recently enlarged; and a literary institute and a school of art have been established. The principal manufactures of the town are nails, buttons, needles, and coarse linen stuffs; and there are also waggon-works and malt-kilns. The population of the Improvement District in 1871 was 6967.

BRONCHITIS, inflammation of the mucous membrane of the bronchial tubes. Well known as one of the most common diseases of the climate of Great Britain, bronchitis exists in either an *acute* or a *chronic* form.

Acute bronchitis, like other inflammatory affections of the chest, generally arises as the result of exposure to cold, particularly if accompanied with damp, or of sudden change from a heated to a cool atmosphere. The symptoms vary according to the severity of the attack, and more especially according to the extent to which the inflammatory action spreads in the bronchial tubes. The disease usually manifests itself at first in the form of a catarrh, or common cold; but the accompanying feverishness and general constitutional disturbance proclaim the attack to be something more severe, and symptoms denoting the onset of bronchitis soon present themselves. A short, painful, dry cough, accompanied with rapid and wheezing respiration, a feeling of rawness and pain in the throat and behind the breast bone, and of oppression or tightness throughout the chest, mark the early stages of the disease. In some cases, from the first, symptoms of the form of asthma known as the *bronchitic* are superadded, and greatly aggravate the patient's suffering. See ASTHMA.

After a few days expectoration begins to come with the cough, at first scanty and viscid or frothy, but soon becoming copious and of purulent character. In general, after free expectoration has been established the more urgent and painful symptoms abate; and while the cough may persist for a length of time, often extending to three or four weeks, in the majority of instances convalescence advances, and the patient is ultimately restored to health, although there is not unfrequently left a tendency to a recurrence of the disease on exposure to its exciting causes.

When the ear or the stethoscope is applied to the chest of a person suffering from such an attack as that now described, there are heard in the earlier stages snoring or cooing sounds, mixed up with others of wheezing or fine whistling quality, accompanying respiration. These are denominated dry sounds, and they are occasionally so abundant and distinct as to convey their vibrations to the hand applied to the chest, as well as to be audible to a bystander at some distance. As the disease progresses these sounds become to a large extent replaced by others of crackling or bubbling character, which are termed moist sounds or râles. Both these kinds of abnormal sounds are readily explained by a reference to the pathological condition of the parts. One of the first effects of inflammation upon the bronchial mucous membrane is to cause some degree of swelling, which, together with the presence of a tough secretion closely adhering to it, tends to diminish the calibre of the tubes. The respired air as it passes over this surface gives rise to the dry or sonorous breath sounds, the coarser being generated in the large, and the finer or wheezing sounds in the small divisions of the bronchi. Before long, however, the discharge from the bronchial mucous membrane becomes more abundant and less glutinous, and accumulates in the tubes till dislodged by coughing. The respired air, as it passes through this fluid, causes the moist râles above described. In most instances both moist and dry sounds are heard abundantly in the same case, since different portions of the bronchial tubes are affected at different times in the course of the disease.

Such are briefly the main characteristics presented by an ordinary attack of acute bronchitis running a favourable course.

The case is, however, very different when the inflammation spreads into, or when it primarily affects the minute ramifications of the bronchial tubes which are in immediate relation to the air-cells of the lungs, giving rise to that form of the disease known as *capillary bronchitis*. When this takes place all the symptoms already detailed become greatly intensified, and the patient's life is placed in imminent peril in consequence of the interruption to the entrance of air into the lungs, and thus to the due aeration of the blood. The feverishness and restlessness increase, the cough becomes incessant, the respiration extremely rapid and laboured, the nostrils dilating with each effort, and evidence of impending suffocation appears. The surface of the body is pale or dusky, the lips are livid, while breathing becomes increasingly difficult, and is attended with suffocative paroxysms which render the recumbent posture impossible. Unless speedy relief is obtained by successful efforts to clear the chest by coughing and expectoration, the patient's strength gives way, somnolence and delirium set in, and death ensues. All this may be brought about in the space of a few days, and such cases, particularly among the very young, sometimes prove fatal within forty-eight hours.

During life, in addition to the auscultatory signs present in ordinary bronchitis, there generally exist in this form of the disease abundant fine moist râles at the bases of both lungs; and the appearance of these organs after death shows the minute bronchi and many of the air-cells to be filled with matter similar to that which had been expectorated, and which has thus acted as a mechanical hindrance to the entrance of the respired air and caused death by asphyxia.

Acute bronchitis must at all times be looked upon as a severe and even serious ailment, but there are certain circumstances under which its occurrence is a matter of special anxiety to the physician. It is pre-eminently dangerous at the extremes of life, and mortality statistics show it to be one of the most fatal of the diseases of those periods. This is to be explained not only by the well recognized fact that all acute diseases tell with great severity on the feeble frames alike of infants and aged people, but more

particularly by the tendency which bronchitis undoubtedly has in attacking them to assume the capillary form, and when it does so to prove quickly fatal. The importance, therefore, of early attention to the slightest evidence of bronchitis among the very young or the aged can scarcely be overrated.

Bronchitis is also apt to be very severe when it occurs in persons who are addicted to intemperance. Again, in those who suffer from any disease affecting directly or indirectly the respiratory functions, such as consumption or heart disease, the supervention of an attack of acute bronchitis is an alarming complication, increasing, as it necessarily does, the embarrassment of breathing. The same remark is applicable to those numerous instances of its occurrence in children who are or have been suffering from such diseases as have always associated with them a certain degree of bronchial irritation, such as measles and hooping-cough.

One other source of danger of a special character in bronchitis remains to be mentioned, viz., collapse of the lung. Occasionally a branch of a bronchial tube becomes plugged up with secretion, so that the area of the lung to which this branch conducts ceases to be inflated on inspiration. The small quantity of air imprisoned in the portion of lung gradually escapes, but no fresh air enters, and the part collapses and becomes of solid consistence. Increased difficulty of breathing is the result, and where a large portion of lung is affected by the plugging up of a large bronchus, a fatal result may rapidly follow, the danger being specially great in the case of children. Fortunately, the obstruction may sometimes be removed by vigorous coughing, and relief is then obtained.

With respect to the treatment of acute bronchitis, in those mild cases which are more of the nature of a simple catarrh, little else will be found necessary than confinement in a warm room, or in bed, for a few days, and the use of light diet, together with warm diluent drinks. Additional measures are, however, called for when the disease is more markedly developed. Medicines to allay fever and promote perspiration, such as the well-known Mindererus spirit, combined with antimonial or ipecacuan wine, are highly serviceable in the earlier stages. Later on, with the view of soothing the pain of the cough, and favouring expectoration, mixtures containing squill or tolu, with the addition of some opiate, such as the ordinary paregorics, may be advantageously employed. The use of opium, however, in any form should not be resorted to in the case of young children without medical advice, since its action on them is much more potent and less under control than it is in adults. Not a few of the so-called "soothing mixtures," have been found to contain opium in quantity sufficient to prove dangerous when administered to children; and, indeed, it is to be feared that fatal results not unfrequently follow their incautious use in this way.

From the outset of the attack the employment of warm applications to the chest in the form of fomentations or poultices affords great relief. Few remedial measures are of greater value than the frequent inhalation of steam. This is accomplished readily enough in the case of adults by the use of an inhaler or simply by breathing over an open-mouthed vessel containing boiling water. In children in whom this plan cannot be carried out in the same manner, there is in general no difficulty in surrounding them with an atmosphere of steam by placing around them vessels containing hot water, the vapour from which envelopes them. The relief to the cough and breathing, and the aid to expectoration afforded by this simple plan, are often surprising, and the cases are rare where it cannot be borne.

Should the cough persist for a length of time, and the disease threaten to become chronic, counter-irritant applications to the chest in front and behind, in the form of stimulating liniments, or even of blisters, will be rendered necessary.

When the bronchitis is of the capillary form, the great object is to maintain the patient's strength, and to endeavour to secure the expulsion of the morbid secretion from the fine bronchi. In addition to the remedies already alluded to, stimulants are called for from the first; and should the cough be ineffectual in relieving the bronchial tubes, the administration of an emetic dose of sulphate of zinc or squill may produce a good effect.

During the whole course of any attack of bronchitis, attention must be paid to the due nourishment of the patient; and during the subsequent convalescence, which, particularly in elderly persons, is apt to be slow, tonics and stimulants may have to be prescribed.

Chronic bronchitis may arise as the result of repeated attacks of the acute form, or it may exist altogether independently. It occurs more frequently among persons advanced in life than among the young, although no age is exempt from it.

The usual history of this form of bronchitis is that of a cough recurring during the colder seasons of the year, and in its earlier stages, departing entirely in summer, so that it is frequently called "winter cough." In many persons subject to it, however, attacks are apt to be excited at any time by very slight causes, such as changes in the weather; and in advanced cases of the disease the cough is seldom altogether absent.

The symptoms and auscultatory signs of chronic bronchitis are on the whole similar to those pertaining to the acute form, except that the febrile disturbance and pain are much less marked. The cough is usually more troublesome in the morning than during the day. There is usually free and copious expectoration, and occasionally this is so abundant as to constitute what is termed *bronchorrhœa*.

Chronic bronchitis leads to alterations of structure in the affected bronchial tubes, their mucous membrane becoming thickened or even ulcerated, while occasionally permanent dilatation of the bronchi takes place, often accompanied with profuse fœtid expectoration. In long standing cases of chronic bronchitis, the nutrition of the lungs becomes impaired, and dilatation of the air-tubes (*emphysema*) and other complications result, giving rise to more or less constant breathlessness. Chronic bronchitis is liable in some instances, particularly when accompanied with loss of flesh and strength, to be mistaken for consumption; but the physician who carefully regards the history of the case and observes the physical signs and symptoms, will in general be able to distinguish the one disease from the other.

Chronic bronchitis may arise secondarily to some other ailment. This is especially the case in Bright's disease of the kidneys, and in heart disease, of both of which maladies it often proves a serious complication.

Chronic bronchitis does not often prove directly fatal, nor is it necessarily inconsistent with long life. Its chief danger lies in the tendency to intercurrent acute attacks, particularly in the aged; and in this manner it very frequently causes death.

The treatment to be adopted in chronic bronchitis depends upon the severity of the case, the age of the patient, and the presence or absence of complications. Attention to the general health is a matter of prime importance in all cases of the disease, more particularly among persons whose avocations entail exposure, and tonics with cod-liver oil will be found highly advantageous. The use of a respirator in very cold or damp weather is a valuable means of protection. In those aggravated forms of chronic bronchitis, where the slightest exposure to cold air brings on fresh attacks, it may become necessary, where circum-

stances permit, to enjoin confinement to a warm room or removal to a more genial climate during the winter months. When expectoration is attended with difficulty, such remedies as squill in combination with ammonia may prove useful. When, on the other hand, bronchorrhœa exists, astringents are called for. The inhalation of vapour containing iodine or turpentine is often followed with marked benefit in this way. Where breathlessness accompanies the disease, besides the use of ethereal preparations, marked relief is often derived from large doses of iodide of potassium. Counter-irritation to the chest with turpentine, mustard, or croton oil is generally attended with good results. In aged and weak persons stimulants are an indispensable part of the treatment. Acute exacerbations of the disease, which are so apt to arise in the chronic form, must be dealt with on the principles already indicated in treating of acute bronchitis. (J. O. A.)

BRÖNDSTED, Peter Oluf, archæologist, was the son of a Danish clergyman, and was born at Horsens in Jutland on 17th November 1781. He received his academical education at the university of Copenhagen; and in 1802 he visited Paris in company with his friend Koes. After remaining there two years, they went together to Italy. Both were zealously attached to the study of antiquities; and congeniality of tastes and pursuits induced them both, in 1810, to join Baron Stackelberg, Von Haller, and Linckh of Stuttgard, in an expedition to Greece, where they examined with attention the interesting remains of ancient art, and engaged with ardour in excavations among the ruins, which were carried on, especially by Bröndsted and Stackelberg, with very interesting results. The discoveries Bröndsted made were made public in several works, which show learning and sagacity such as have seldom been applied to the elucidation of antiquity with happier results. After three years of active researches in Greece, Bröndsted returned to Copenhagen, where, as a reward for his labours, he was appointed professor of Greek in the university. He now began to arrange and prepare for publication the vast materials he had collected during his travels; but finding that Copenhagen did not afford him the desired facilities, he exchanged his professorship for the office of Danish envoy at the papal court in 1818, and took up his abode at Rome. He also, in 1820 and 1821, went to Sicily and the Ionian Isles to collect additional materials for his great work; and when the artistic illustrations were completed, he obtained leave to visit Paris to superintend the publication. In 1826, he came over to London, chiefly with a view to study the Elgin marbles and other remains of antiquity in the British Museum, and became acquainted with the principal archæologists of England.

He returned to Copenhagen in 1832, when he immediately received the appointment of director of the royal museum of antiquities, and the professorship of archæology and philology. His merits were ten years afterwards further rewarded with the honourable office of rector of the university; but an unlucky fall from his horse caused the death of this eminent man on the 26th June 1842. His principal work was the *Travels and Archæological Researches in Greece*, published in German and French, 1826–30. His dissertations on points of ancient art are very numerous.

BRONGNIART, Alexandre, a distinguished French mineralogist, was the son of the eminent architect who designed the Bourse and other public buildings of Paris, and was born in that city in 1770. At an early age he joined the army of the Pyrenees; but having committed some slight political offence, he was thrown into prison, and detained there for some time. On his release he was appointed professor of natural history in the Collége des Quatre Nations, and soon after succeeded Haüy as professor in the school of mines. In 1800 he was made director of the Sèvres porcelain factory, in which he revived the almost forgotten art of painting on glass. He did not confine himself entirely to mineralogy, for it is to him that we owe the division of Reptiles into the four orders of Saurians, Batrachians, Chelonians, and Ophidians. In 1816 he was elected into the Academy; and in the following year he visited the Alps of Switzerland and Italy, and afterwards Sweden and Norway. The result of his researches he published from time to time in the *Journal des Mines* and *Dictionnaire des Sciences Naturelles*. He died at Paris, October 7, 1847.

His principal works are—*Traité élémentaire de minéralogie appliquée aux Arts*; the *Tableau des terrains qui composent l'écorce du globe, ou Essai sur la structure de la partie connue de la terre*; and the *Traité des Arts céramiques* 1845. Brongniart was also the coadjutor of Cuvier in the admirable *Essai sur la géographie minéralogique des environs de Paris*.

BRONTE, a city of Sicily in the intendency of Catania. It stands in a healthy situation at the western foot of Mount Etna, on the river Giaretta, near a celebrated waterfall. It has considerable manufactures of linen and woollen cloths, and some paper-mills. Good wine is produced in the neighbourhood. Bronte is of comparatively modern origin, having all been built since the 16th century. It gave the title of duke to Lord Nelson. Population, 14,589.

BRONTE, Charlotte, modern English novelist, was born on the 21st April 1816. Her father, the Rev. Patrick Bronte, was a native of county Down, Ireland; her mother, Maria Branwell, was of Cornish family. At the date of his marriage, in 1812, Mr Bronte held the living of Hartshead in Yorkshire, and there his two eldest daughters, Maria and Elizabeth, were born. In 1815 he removed to Thornton, in the parish of Bradford, where Charlotte, her brother Patrick Branwell, and her younger sisters, Emily and Anne, were born. In 1820 he was presented to the living of Haworth, and removed in that year to the parsonage, a bleak and solitary house, standing close by the churchyard and backed by a wide expanse of moorland. Mrs Bronte died soon after their removal, and the little family of young children were left to educate and train themselves. They saw little of their father, whose health was bad, and who seems to have been eccentric in his modes of thinking and acting. The charge of the little flock devolved upon the eldest daughter, a girl of between seven and eight when her mother died; and, under the peculiar circumstances of their life, the children's intellectual powers and sympathies developed with rapidity. Utterly deprived of all companions of their own age, with none of the usual outlets for their pent-up energies, they lived in a little world of their own. The harsh realities around them, the bleak scenery, the coarse and rugged natures of the few inhabitants with whom they came in contact, only impelled them to construct for themselves an ideal world, modelled after their own strange and untrained imaginations, in which they found satisfaction and reality. By the time Charlotte Bronte was thirteen years of age, it had become her constant habit, and one of her few pleasures, to weave imaginary tales, idealizing her favourite historical heroes, and bodying forth in narrative form her own thoughts and feelings. Nor was she alone in this curious occupation; all the family took part in the composition of juvenile stories and magazine articles. It was a strange training for a child, boding little good for her future happiness when thrown into the ordinary routine of life.

An event which made a deep impression on this strange family circle was the entering of the two eldest girls, in 1824, at a school recently opened at Cowan's Bridge, near Haworth, and intended for daughters of clergymen. A vivid picture of this school, and one which Miss Bronte always maintained was not over-coloured, is presented in *Jane Eyre*, for the Lowood of that story is Cowan's Bridge.

Of all pupils the Brontes were the least likely to fall in well with the requirements of their new mode of life. Everything was novel and repulsive to them; their peculiar natures were repressed and stunted; their intellectual sympathies found no food. Charlotte and Emily became pupils later in the same year, but it was soon found necessary to remove Maria. Her health had given way completely, and she died a few days after her return to Haworth in the spring of 1825. But a few months later and Elizabeth followed her sister to the grave. The younger girls were removed in the autumn of 1825; and Charlotte, as the eldest of the household, took upon herself the duties that Maria had formerly discharged. For six years she remained at home leading the usual quiet, isolated life, and indulging to the full her rare faculty of composition. She then spent one of her happiest years in a school at Roe Head, and some of the acquaintances made there became life-long friends. To this school she returned in 1835 in the capacity of teacher, and for a time her sisters were with her as pupils. After three years her health, always delicate, gave way alarmingly, and she had to be withdrawn to Haworth. Two short experiences as governess in a family having shown her how little such a life was suited to her, she turned her thoughts towards taking a school, a plan which would have had the special advantage of keeping together the three devoted sisters. Some money was advanced for this scheme by their aunt, and it was resolved that, as a preliminary step, Charlotte and Emily should study French upon the Continent. In 1842, accordingly, they found themselves in Brussels, and a new world, a new experience, was opened up to Miss Bronte's vigorous and imaginative mind, a world to be afterwards reproduced in living characters. She studied hard, and before her return to England in January 1844 had acquired a very thorough knowledge of French.

She came back to a home into which a fresh element of unhappiness had been introduced. Her brother Patrick, a youth of fine talents, had fallen into habits of dissipation, which rapidly rendered him a hopeless drunkard. For some years the sisters had the misery of seeing daily before them the spectacle of a wasted life, of powers thrown away, and of opportunities despised. The details of his unfortunate story may well rest in obscurity. He lingered on till September 1848.

Meanwhile, amid their distress, the sisters, who found refuge in their habits of composition, had made their first literary venture. During their separation, while Charlotte was in Brussels, and Anne in a situation as governess, they had been quietly pursuing their favourite occupation; and in 1845 they made the discovery of each other's poetical efforts. After some correspondence with publishers they resolved to print a small volume of poems, assuming the *noms de plume* of Currer, Ellis, and Acton Bell. The book appeared in the spring of 1846, was barely noticed by the reviews, and attracted no public attention. The authors, however, were encouraged to make a further trial, and each began to prepare a prose tale. Charlotte's was *The Professor*; Emily's, *Wuthering Heights*; Anne's, *Agnes Grey*. *The Professor* was refused on all hands; the other two were accepted, but their publication was delayed for some time. Nothing daunted by her want of success, Charlotte devoted herself heart and soul to a new tale, *Jane Eyre*, which she completed in August 1847. The MS. was accepted by Messrs Smith and Elder; the book appeared with the name of Currer Bell on the title page in October 1847, and at once achieved a decided success.

Few works of an unknown author have been received with such sudden and general acclamation. The utter and even paradoxical disregard for the conventional which the book displayed, the masculine vigour and glowing energy with which the main characters were drawn, and its intense realism, at once seized and secured the popular favour, and showed the literary world that a new and powerful competitor for its honours was in the field. Its success was not so much the result of the favourable verdicts of trained judges, for these came but slowly, as of its own intrinsic force. The delineation of the harsh and rugged but powerful northern character was the revelation of a new world, and the intensest interest was excited as to the true name and abode of the unknown author. Numerous were the conjectures as to Currer Bell, but the secret was well kept. Even the publishers were unaware of the truth, till the disclosure had to be made to them in consequence of the publication of *Wuthering Heights* and *Agnes Grey*, and of the announcement of *The Tenant of Wildfell Hall*. The public, however, remained in the dark till after the appearance of the second work by the unknown, when a shrewd Yorkshireman, who knew Haworth, divined the secret and published his discovery.

Shirley, this second work, fully sustained the author's high reputation. Yet it was written under melancholy circumstances. The death of Patrick Bronte, in September 1848, was followed by the deaths of Emily and Anne in quick succession. Emily died on the 19th December 1848; Anne on the 28th May 1849. *Shirley* was published in October 1849. The disclosure of Miss Bronte's name as the writer at once introduced her to the great literary society of London. She met all the most prominent men of letters of the time; yet, though she was in the world, she was not of it. Her previous life and her peculiarly sensitive and retiring disposition made notoriety and attention painful to her, and she gladly escaped to the quiet of Haworth parsonage. Slowly, and with long interruptions from failing health, her last work proceeded to completion. *Villette* was published in 1853, and was hailed with universal delight. It is in some respects the most pleasing of her works, while it at the same time exhibits some of her gravest faults. The description of the life at the foreign *pension*, and the whole delineation of the principal characters, are reflexes of her own experience, and impress one with their vivid reality and truth. The plot, however, is unskilfully constructed, and the interest seems to shift from one set of characters to another in the progress of the story.

In June 1854 Miss Bronte was married to her father's curate, the Rev. Mr Nicholls, and for a brief period she tasted the strange new happiness of domestic life. But the seeds of decay were in her constitution; the same malady that had carried off her sisters, worked its way with fatal facility in her enfeebled frame. She died on the 31st March 1855. After her death *The Professor*, her first luckless tale, was published from her MSS.

A comparison has sometimes been made between Miss Bronte and Miss Austen. The points of contrast are certainly more apparent than the points of similarity; and it is a fact not without significance that Miss Bronte could never thoroughly appreciate the merits of her great predecessor. Both were consummate masters of literary expression, and both finished their work with the utmost care and precision. Miss Austen is distinctly superior in skilful evolution of plot and in the nice adjustment of character and incident. But her figures are tame and lifeless when compared with those of Miss Bronte, and what she chiefly lacked, the fierce glow and fire of imagination, and the perception of depths in human nature only revealed through suffering experience, the other possessed to an almost unrivalled extent. Miss Bronte's experience was, indeed, narrow, but it was of a rare kind, such as was peculiarly adapted to her strong and yet sensitive spirit. She had too what Goethe calls the true secret of poetic genius,

penetration to the individual and real; what she had herself known and felt, the deep impressions made on her mind by wild scenery, and by rugged yet genuine human natures, that she mirrored forth with living truth and fiery vehemence. Doubtless her strength at times approaches too near to coarseness, the situations become almost melodramatic, and the result may be charged with sensationalism, but the pervading sense of intense reality is more than sufficient to carry off these defects.

Of her three great works *Jane Eyre* will always be the one which occurs most readily in connection with her name; it has all the vigour and individuality of a first-born work of genius. *Shirley*, one of the sweetest love-stories in the range of English fiction, abounds in rich humour, but wants the perfection of artistic unity. *Villette* contains, perhaps, more of the author's personality than either of the others. The character of the heroine is in truth that of Miss Bronte herself, and the analysis of it is at times morbidly acute. *The Professor* has never gained much popularity, though the main conception is one of great beauty and is skilfully handled.

Of EMILY BRONTE's works it is somewhat difficult to speak. Hers was a strange nature, not easily understood; and it had but little time to develop. Some of her poems are singularly powerful, and show uncommon abilities. *Wuthering Heights* is a literary curiosity. Unmistakably the work of a strong mind, into which the wild scenery of the north had sunk deeply, it shows absolutely no comprehension of human character. We are transplanted to a dreamland, enveloped in a lurid thunderous atmosphere, through which stalk fantastic giant beings, gloomy and devilish in their utter wickedness. It is the production of a powerful imagination, but of an imagination unrestrained by any experience of the real, and regulated by no considerations of artistic beauty and proportion.

ANNE BRONTE's was a mind of weaker calibre. *Agnes Grey* is a gentle, gracefully written tale, founded on the writer's own experiences of a governess's life; but it manifested little power or promise. *The Tenant of Wildfell Hall* has much greater force and vigour; but the main conception is an unpleasant one over which the writer had brooded until she had been seized with a morbid craving to give it shape and substance. It is a painful story, inartistically told.

Charlotte Bronte's friend, Mrs Gaskell, has narrated her life, as only a woman of kindred genius could. Of Emily and Anne, incomparably the best notice is that prefixed by Charlotte Bronte to the second edition of *Wuthering Heights* and *Agnes Grey*. A new and uniform edition of the whole works of the three sisters, with Mrs Gaskell's *Life* (which first appeared in 1875), illustrated by engravings of the principal places mentioned, is at present (1876) in course of publication.

BRONZE is an alloy formed wholly or chiefly of copper and tin, in variable proportions. It has been used from a very early period. Archæologists distinguish a *bronze age* in prehistoric times in Western Europe (intermediate between those of stone and iron), characterized by a general use of the alloy for cutting instruments and other objects. The "brass" of the Bible was probably of the nature of bronze. The use of bronze in early times is noticed more particularly below.

The addition of tin to copper gives rise to a product more fusible than copper, and thus better suited for casting. The alloy is also harder and less malleable. The proportions in which copper and tin are combined to make bronze vary according to the object for which the alloy is designed. With about 7 parts copper to 1 part tin, bronze is very hard, brittle, and sonorous. Soft bronze, again, which bears drifting, rolling, and drawing, is generally composed of 16 copper to 1 tin; while a flexible tenacious alloy, good for nails and bolts, is made of 20 copper to 1 tin. In preparing bronze for statues, bas-reliefs, &c., the qualities chiefly looked at are fusibility and hardness, also readiness to acquire a fine patina on exposure, though it appears this may be acquired by bronzes differing widely in composition. A common statue bronze is formed of copper 80, tin 20. Bell-metal, for large bells, is generally made with about 3 parts copper to 1 part tin; for house bells, 4 copper to 1 tin. The bronze of bells (as of various other objects) sometimes contains a little zinc, lead, &c., in addition to the primary ingredients. The Chinese *tam tams* or *gongs*, are made of bronze forged by the hammer; they contain about 20 per cent. tin, the rest copper only. The secret of their manufacture seems to have been revealed by MM. Julien and Champion, who find that a bronze of this nature, though at the common temperature brittle as glass, may, at a dull red heat, be forged and beaten out as easily as soft tin. The speculum metal employed in telescopes is of 2 copper to 1 tin; and on the other hand, with larger proportions of copper, we have an alloy suitable for machinery bearings, and also for medals, 8 copper to 1 tin; another for brass ordnance or bronze cannon, 9 copper to 1 tin; another for mathematical instruments, 12 copper to 1 tin, &c. The hardness and resistance to oxidation of bronze fit it admirably for coins, and many ancient bronze coins have come to us but little deteriorated, though buried for ages in damp soil, or immersed in water. The composition of the present bronze British coinage is (in 100 parts) 95 copper, 4 tin, 1 zinc.

A few years ago some very beautiful Chinese and Japanese bronzes were exhibited in Paris, remarkable chiefly for the dead black colour of their patina. From analyses by M. Morin it appeared that they contained a large proportion of lead, the average composition being copper 80 parts, lead 10, tin 4, zinc 2, and the remaining four parts consisting of iron, nickel, arsenic, silver, and gold. According to M. Christofle, lead is not essential for production of a fine black patina; and it renders the alloy brittle. Bronze can be covered with a black, red, brown, or green patina, as desired, by suitable oxidation or sulphurization.

Some important researches on bronze for field-guns have lately been made by Colonel Uchatius of Vienna; and the *steel bronze* he produces is said to be quite equal to steel in hardness, homogeneousness, resistance, and other qualities; while it is less affected by atmospheric agency, and less costly. He casts the bronze (which contains 8 per cent. tin, the rest copper) in a cast-iron ingot mould, with a core of wrought-copper 50 mm. in diameter. Then after boring out the hollow ingot to a diameter of 80 mm. he forces through it a series of six conical pistons of hardened steel, slightly larger in diameter than the bore. The interior is then excessively hard and ready for rifling. The hardness, elasticity, and solidity diminish from within outwards. These new bronze guns have been found to bear several hundred discharges successively without the slightest apparent deformation or other injury.

It is only of late years that the changes produced in bronze by addition of phosphorus have been scientifically investigated; and from experiments by Messrs Montefiore, Künzel, Kirkaldy, and others, *phosphor bronze* is proved to have great superiority to ordinary bronze in tenacity, elasticity, and tensile strength (being to it much what steel is to wrought iron). The presence of oxides in ordinary bronze accounts for its possessing these qualities in less degree, and phosphorus increases them by reduction of the metal. Phosphor bronze is further greatly improved in tensile strength by being drawn into wire or rolled into sheets; and it resists the action of sea-water much better than copper. Such a substance cannot fail to find many important applications, military, industrial, and domestic. In virtue of its reducing properties, we may add, phosphor bronze can be platinized better than any other metal.

The alloy known as *aluminium bronze* is one endowed with great strength, malleability, and ductility. It is formed of 10 parts aluminium and 90 of copper.

In the melting of ordinary bronze, reverberatory furnaces have long been used, as rapid fusion is desirable in order to prevent loss of tin, zinc. or lead by oxidation. Bellfounders often use dome-topped furnaces, as their alloy does not require so intense a heat for fusion; but there is some waste of material with these. The copper is melted first, and covered with small charcoal or coke; and the tin is rapidly thrust down to the bottom of the melted mass. After stirring, the alloy is poured into the moulds, in which the cooling should be as rapid as possible. Sometimes pressure is applied during cooling, in order to make the cast free from pores.

In the old method of bronze-casting, known as the *cire perdue*, wax is first used for the thickness of the statue (between core and mould, which are of baked clay), and is melted and run off before the metal is poured in,—the core and mould being held apart by stays of iron wire. In the present day large works are never cast in one piece, but in several, which are afterwards united by heating and application of fused metal. A model is made in plaster, and a piece mould of Caen sand, about 1½ or 2 inches thick, made round it, the sizes of the pieces being determined by the shape and character of the portions they occupy. These pieces are backed with plaster of Paris to about a foot in thickness, with indentations cut in their horizontal thickness, into which the succeeding portion of the mould fits. The mould is then taken to pieces, dried, and rebuilt in the casting-pit. It is then filled with core-composition in a liquid state, and when this is sufficiently hardened, again taken to pieces. The core thus obtained is thoroughly dried, and reduced in size by scraping away as much of the material as would represent the thickness of the metal to be cast. This done, the mould is again built up over the core, and the pit filled, &c., as in the other process. The statue is completed after its removal from the mould by cutting off the jets, removing roughnesses where they occur, and giving greater sharpness to the details when necessary.

Statues and various ornamental objects may also be manufactured by the process of electro-deposition from a metallic solution; and some excellent results have been obtained in this way by Oudry, Christofle, Elkington, and others. While the method offers some advantages in regard to cheapness, lightness, &c., of the products, the bronzes thus produced are not so hard and durable as those got by casting, and are thus less suited for exposure.

Bronzing is the process by which a bronze-like surface is produced on objects made of metal, plaster, wood, or other material. It may be done variously. The green bronze colour is sometimes produced on metal with vinegar alone, or dilute nitric acid, or sal-ammoniac. To give an antique appearance to newly made articles of bronze or brass, it is recommended to dissolve three-quarters of an ounce of sal-ammoniac and a drachm and a half of binoxalate of potash (salt of sorrel) in a quart of vinegar, moisten a soft rag or brush with the solution, and rub over the clean bright metal till its surface becomes quite dry through the friction. This process should be repeated several times, and the object should be kept a little warm. With a solution of chloride of platinum (which is, however, an expensive liquid) almost any colour can be imparted to copper, brass, iron, or new bronze, according to the degree of dilution and number of applications. The following solution is suitable for bronzing coins and medals:—Two parts of verdigris and one part of sal-ammoniac are dissolved in vinegar, the solution is boiled, skimmed, and diluted with water till it has only a weak metallic taste, and on further dilution lets fall no precipitate. This solution is made to boil briskly and poured on the objects. These are well washed with clean water and then lacquered.

Objects of cast-iron may be made to assume a fine bronze appearance by being coated with a very thin layer of vegetable oil, and then placed in a drying oven, the temperature being such that oxidation of the iron and decomposition of the oil take place simultaneously. Another mode of bronzing iron (lately recommended by Weiskopf) is with a solution of one part sylvate of silver in twenty parts of oil of lavender. The object is lightly coated with this, and warmed rapidly up to 302° C. For bronzing tin or white metal a solution may be used consisting of 1 oz. sal-ammoniac, ½ oz. alum, and ½ oz. arsenic, dissolved in 1 pint of strong vinegar.

A good method of bronzing wood, porcelain, stoneware, composition picture and looking-glass frames, &c., is first to coat the article with a thin solution of water glass, using a soft brush. Bronze powder is then dusted on, and any excess not adherent is knocked off by a few gentle taps. The article is next heated to dry the silicate, and the bronze becomes firmly attached. Bronze powders are prepared of many different shades. In Messrs Brandeis's process the alloy used (generally copper-zinc) is laminated into very fine leaves, which are then ground. The powder is washed out and dried, and by revolving in a box, which contains some mineral varnish, the particles receive a coating of the varnish. Bronze powders are also prepared from leaf gold ground with honey on a stone, mosaic gold ground with bone ashes, compounds of tungsten and soda, and in other ways.

As regards cleansing of bronze statues that have become coated with dirt in large towns, it has been found that a dilute solution of caustic alkalies removes the overlying dirt and allows the green patina to become visible. Where the metal was not originally oxidized, the alkali simply cleanses it and does not promote any formation of green rust. An occasional rubbing with oil (all excess being carefully removed) is also found to preserve a fine bronze surface. The shining brown colour of gun barrels or other arms, is sometimes imparted by first producing a very thin uniform film of oxide or rust on the iron, *e.g.*, with vapour of muriatic acid, and giving a gloss to the surface by rubbing wax over it, or coating it with a shellac varnish. But the most common material for browning is the butter or chloride of antimony, sometimes called *bronzing-salt*. It is mixed with olive oil and rubbed on the iron, which is slightly heated. A little aquafortis is then rubbed on to quicken the operation; the barrel is then cleaned, washed with water, dried and polished, either with a steel burnisher, or by rubbing with white wax, or is varnished with a very weak solution of shellac and spirit of wine. (See Ure's *Dictionary of Arts*, &c.)

Greek and Roman Bronze.

The bronze (Greek, χαλκός; Latin, *æs*) of *classical antiquity* consisted chiefly of copper, with an alloy of one or more of the following metals, zinc, tin, lead, and silver, the quantity and the character of the alloy changing as times changed, or as was required for different purposes. Among existing bronze remains the copper is found to vary from 67 to 95 per cent. At present the only valuable results which we possess are derived from the analysis of coins (Von Bibra, *Die Bronzen und Kupferlegirungen der alten und ältesten Völker*, Erlangen, 1869), from which it appears that for their bronze coins the Greeks adhered to an alloy of copper and tin till 400 B.C., after which time they used also lead with increasing frequency. Silver is rare in their bronze coins. The Romans also used lead as an alloy in their bronze coins, but gradually reduced the

quantity, and under Caligula, Nero, Vespasian, and Domitian, coined pure copper coins; afterwards they reverted to the mixture of lead. So far the words χαλκός and æs may be translated as bronze. Originally, no doubt, χαλκός was the name for pure copper. It is so employed by Homer, who calls it ἐρυθρός (red), αἴθωψ (glittering), φαεινός (shining), terms which apply only to copper. But instead of its following from this that the process of alloying copper with other metals was not practised then, or was unknown to the poet, the contrary would seem to be the case from the passage (*Iliad*, xviii. 474) where he describes Hephæstus as throwing into his furnace, copper, tin, silver, and gold, to make the shield of Achilles, so that it is not always possible to know whether when he uses the word χαλκός he means copper pure or alloyed. Still more difficult is it to make this distinction when we read of the mythical Dactyls of Ida in Crete or the Telchines or Cyclopes being acquainted with the smelting of χαλκός. It is not, however, likely that later Greek writers, who knew bronze in its true sense, and called it χαλκός, would have employed this word without qualification to objects which they had seen unless they had meant it to be taken as bronze. When Pausanias (iii. 17, 6) speaks of a statue, one of the oldest figures he had seen of this material, made of separate pieces fastened together with nails, we understand him to mean literally bronze, the more readily since there exist very early figures and utensils of bronze so made. The earliest employment of bronze for artistic purposes was to hammer it out in thin plates and fasten them together with nails. This process was called *sphyrelaton*. The next stage was casting, in connection with which the earliest Greek artists of fame are Theodorus and Rhœcus of Samos (Pausanias, viii. 14, 8, and x. 38, 5). It has been supposed that their merit consisted in introducing the process of casting statues hollow, that is, with an inner core of some material which could afterwards be removed and leave the figure light, less costly, and no less durable. There are remains of Assyrian bronze, probably older than the time of Theodorus and Rhœcus, cast with an inner core of iron; and there is also in the British Museum an early Etruscan statuette from Sessa on the Volturno, with a core of this metal, which from its being split down the side, owing to the expansion of the iron, shows how unserviceable the iron was for this purpose. Obviously the power of casting in bronze, whether solid or hollow, was a very great gain to sculptors, whose models worked in the clay with the rapidity of their inspiration could thus be accurately and at once reproduced. The difficulty and expense of the process must have been against it as compared with marble; yet it was frequently employed, and in the case of colossal statues it had no rival. Of these the Colossus of Rhodes —a figure of the sun-god Helios, said to have been 70 cubits high—was an example of the utmost that art could do with bronze. It was thrown down by an earthquake after standing fifty-six years. A statue of Zeus at Tarentum by Lysippus was 40 cubits high, and though it could be moved with a touch of the hand, yet it resisted the force of storms by means of a support at the point of the greatest stress. The oldest seat of bronze-founding, at least to any extent, was the island of Delos, and next to that the island of Ægina, and yet copper does not appear to have been found in either. Between the two there existed a rivalry in the time of the sculptors Myron and Polycletus, of whom the former used the bronze of Delos, the latter that of Ægina. More celebrated than either was the bronze of Corinth, which some believed to have been first obtained by the melting together of statues of ordinary bronze, gold, and silver at the burning of that town. Pliny says that it consisted of gold, silver, and copper, and was considered more precious than silver and little less valuable than gold. There were three kinds of it—one white, having almost the appearance of silver, in which silver predominated; another yellow, because of the great quantity of gold in it; and a third in which all three metals were equally represented. But the Corinthian bronze was used rather for drinking cups and utensils than for statues. The process of casting statues as given by Pliny was to bring the mass of copper to a liquid state, and then to throw into it a third part of old bronze and 12½ per cent. of *plumbum argentarium*, *i.e.*, tin and lead in equal parts.

Of the vast number of bronze statues by ancient sculptors nothing beyond a few fragments remain; but if the colossal bronze head of Venus in the British Museum be taken as a typical example, it will show with what fineness and thinness those figures were cast; or, again, as an instance of the quality of Greek bronze we may take the bronzes of Siris, also in the British Museum, on which a very thin plate of bronze will be seen in some parts of the figures beaten out nearly half an inch till it reaches the thinness of note-paper. Works in relief (τόρευμα), whether beaten out or chased, like those just mentioned, or cast, are comparatively rare, though this branch of art was largely practised even by the greatest sculptors. On the other hand, it does not appear to have been carried out by them to the extent in which it is found in Germany and Italy after the beginning of the 11th century,—for instance, in the reliefs on cathedral gates. The temple of Athene Chalkioikos in Sparta, with its walls covered with bronze reliefs, stands out as an exception. By the time of the Byzantine empire, when the power of modelling had declined, and a taste for glittering appearance took its place, the process of ornamenting bronze with reliefs was superseded by inlaying it with silver and other materials. As to the colour of the ancient bronzes little can now be said, because from lying so long in the earth they have become covered with what is technically called a *patina*, which is generally some shade of green, though sometimes also nearly blue, and at other times drab. This blue colour is very brilliant in bronzes from Herculaneum and Pompeii. A difference of soil very probably makes a different patina, but something may also be due to varieties in the alloy. Perhaps the finest examples of patina are to be found among the bronze mirrors, in which there seems to have been generally a considerable quantity of silver for the sake of obtaining a highly reflecting surface. It does not appear that the process of gilding bronze was carried to any extent in classical times, unless, perhaps, in the production of finger-rings, of which a considerable number remain. But if larger works in bronze fail, there is an abundance of statuettes, candelabra, mirrors, *cistæ*, and vessels of all kinds—Greek, Roman, and Etruscan. One fact to be noticed is that the great number of bronze mirrors which exist are nearly all Etruscan. A few may be Roman from the Latin inscriptions which they bear, and a few also come from Greece. But the general rule of their being Etruscan reminds us of the reputation which the Etruscans enjoyed for the production of works in bronze, not of high art, but of what might be called industrial art. They were celebrated also for modelling in clay; and that, as Pliny states, was the stage of art which immediately preceded casting in bronze, and went hand in hand with it.

The art of bronze casting, which had sunk with the Byzantine empire, was again revived with great vigour in Germany in the 11th century, from which period are the bronze gate of the cathedral at Hildesheim (1015) and the column decorated with reliefs on the model of the column of Trajan in Rome (1022). In the 12th century the art spread southward to Italy, and at first was taken up energetically in Lower Italy. But though many interesting works of this kind exist also from the 13th and 14th

centuries, it was not till the 15th that the art obtained its complete mastery under the Florentine artists. In the following century, again, it is found carried with extraordinary skill in Germany at Nuremberg, Augsburg, Munich, and Coburg. Since then, however, the higher order of sculpture in bronze may be said to have reverted to nearly its ancient limits, that is, the production of statues and groups in the round. (See Dr C. Bischoff, *Das Küpfer in der vorchristlichen Zeit*, Berlin, 1865; and L. R. v. Fellenberg, *Analysen von antiken Bronzen*, 1865.)

BROOCH, or BROACH, (from the French *broche*), an awl or bodkin. A spit is sometimes called a *broach*, and hence the phrase "to broach a barrel." The term is now used to denote a clasp or fastener for the dress provided with a pin, having a hinge or spring at one end, and a catch and loop at the other. Brooches were universally used among the more civilized nations of antiquity. They were made of many materials, and in innumerable varieties of ornamental design, the forms varying according to the period of their manufacture, or the taste and culture of the people using them. They are unknown in the Swiss Lake settlements of the Bronze Age, though pins and bracelets are abundant. Brooches of the Bronze Age are extremely rare in Britain, although they occur in considerable numbers and of elegant forms in North Germany and Scandinavia. The simplest is similar to that which has been reproduced in modern times as the "patent safety-pin," but having the ends prolonged into flat spirals and the clasp flattened and engraved with ornamental designs. Another characteristic form was produced by winding a long wire into a flat double-spiral, of which one end formed the pin and the other the catch. A third form consisted of two round ornamented plates connected by a bow-shaped centre piece. In the early Iron Age the brooches of Central Europe exhibit an immense variety of forms, which are for the most part bow-shaped or harp-shaped, with spring-pins, akin to the types found in the Etruscan cemeteries of Certosa and Villanova recently explored. The Frankish group exhibits three well-defined types, viz., an imitation of animal forms, a simple disc, and a cruciform type, of which there are innumerable varieties of form. The Merovingian brooches were made in gold, silver, or bronze, adorned with precious stones, filagree-work, or enamel; but whatever the richness of the brooch, the pin was always of iron. The Scandinavian or Northern group exhibits a similar cruciform variety more massive in form and richly chased, the terminating knobs fashioned into the similitude of animals' heads. This form occurs also in Anglo-Saxon graves in England. The Anglo-Saxon brooches were exquisite works of art, ingeniously and tastefully constructed. In Kent the circular form predominates. They are often of gold, with a central boss exquisitely decorated, the flat part of the brooch being a mosaic of turquoises, garnets on gold-foil, mother of pearl, &c., arranged in geometric patterns, and the gold work enriched with filagree or decorated with dragonesque engravings. Sometimes the brooch was cruciform and ornamented with chased work and settings of paste or precious stones. The Scandinavian brooches of the Viking time were oval and bowl-shaped, formed of an under shell of impure bron[illegible] gilt on the convex side, and covered by an upper shell of open chased-work ornamented with bosses, or open crown-like ornaments, or animals' heads. The geographical distribution of these peculiar brooches indicates the extent of the conquests of the Northmen. They occur in northern Scotland, England, Ireland, Iceland, Normandy, and Livonia. The Celtic group is characterized by the penannular form of the ring of the brooch and the greater length of the pin. They are usually of bronze or silver, chased or engraved with intricate designs of interlaced or dragonesque work in the style of the illuminated Celtic manuscripts of the 7th, 8th, and 9th centuries. The Hunterston brooch, which was found at Hawking Craig in Ayrshire, is a well-known example of this style. Silver brooches of immense size, some having pins 15 inches in length, and the penannular ring of the brooch terminating in large knobs resembling thistle heads, are occasionally found in Viking hoards of this period, consisting of bullion, brooches, and Cufic and Anglo-Saxon coins buried on Scottish soil. In mediæval times the form of the brooch was usually a simple, flat circular disc, with open centre, the pin being equal in length to the diameter of the brooch. They were often inscribed with religious and talismanic *formulæ*. The Highland brooches were commonly of this form, but the disc was broader, and the central opening smaller in proportion to the size of the brooch. They were ornamented in the style so common on Highland powder-horns, with engraved patterns of interlacing work and foilage, arranged in geometrical spaces, and sometimes mingled with figures of animals.

BROOKE, FRANCES, a clever novelist and dramatic writer, whose maiden name was Moore, was born in the earlier part of the 18th century. Of her novels, some of which enjoyed considerable popularity in their day, the most important were *The History of Lady Julia Mandeville, Emily Montague*, and *The Excursion*. Her dramatic pieces and translations from the French are now wholly forgotten. She died in January 1789, two days after her husband.

BROOKE, HENRY, novelist and poet, was born at Rantavan, county Cavan, in 1708. His father was rector of Killinkere; his mother was a daughter of the bishop of Elphin. At an early age he entered Dublin University, where he was noticed by Swift, who predicted great things of him. About 1724 he proceeded to London, where he managed to gain the affection and esteem of Pope. He studied law in the Temple, and in 1728 married his ward and cousin, Catherine Meares, a girl of fifteen. His first literary venture appears to have been the poem *Universal Beauty* (1730), in which there is exceedingly little that can be admired or even tolerated. A much more successful venture was the drama *Gustavus Vasa*. The prohibition of this play induced the author to publish it, and the sale of the printed copies was enormous. Brooke is said to have cleared 1000 guineas by it. In 1740 his health gave way; he retired to Rantavan, and never returned to his life in London. In 1745 he was made barrack-master at Mullingar, and his well-meant pamphlet, *Secret History and Memoirs of the Barracks of Ireland*, excited much ill-feeling against him. He spent the remaining years of his life in literary work. His dramas were numerous, and some of them kept the stage for a considerable length of time. The work by which he is best known, *The Fool of Quality*, began to appear in 1768. It is the product of the matured experience of the author, and though deficient in many of the qualities that go to form the excellence of a work of fiction, it is forcibly and clearly written, and contains much sound and advanced thinking on social problems. Brooke died in 1783. An edition of the *Fool of Quality* was published in 1859 by the Rev. Charles Kingsley, in whose extravagantly eulogistic preface will be found all the information we have with regard to the author's life and character.

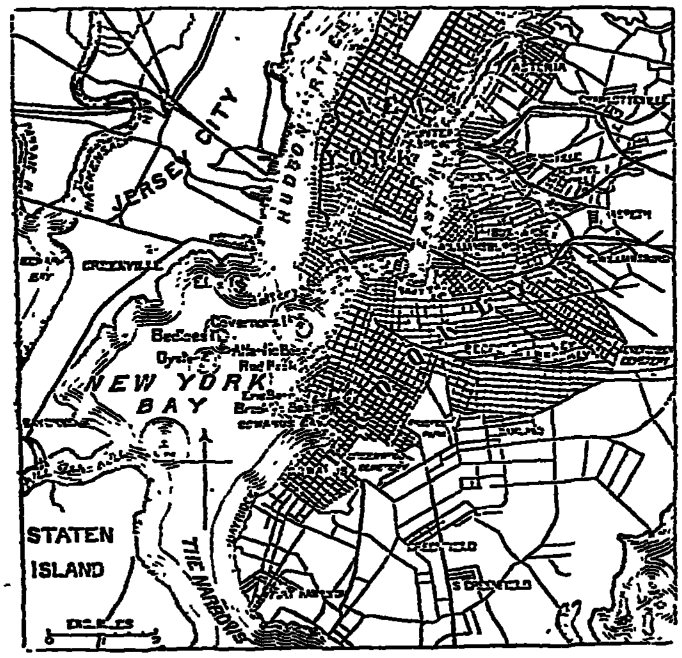
BROOKE, SIR JAMES, Rajah of Sarawak, in the island of Borneo, and Governor of Labuan, was born at Coombe Grove near Bath, April 29, 1803. It is sometimes erroneously stated that he was born in Bengal, a mistake arising from the fact that his father a member of the Civil Service

of the East India Company, had long lived there. His mother was a woman of superior understanding, and to her care he owed his careful early training. He received the ordinary school education, entered the service of the East India Company, and was sent out to India about 1825. On the outbreak of the Burmese war, he was despatched with his regiment to the valley of the Brahmaputra; and, being dangerously wounded in an engagement near Rungpore, was compelled to return home (1826). After his recovery he travelled on the Continent before going to India, and circumstances led him soon after to leave the service of the Company. In 1830 he made a voyage to China, and during his passage among the islands of the Indian Archipelago, so rich in natural beauty, magnificence, and fertility, but occupied by a population of savage tribes, continually at war with each other, and carrying on a system of piracy on a vast scale and with relentless ferocity, he conceived the great design of rescuing them from barbarism and bringing them within the pale of civilization. His purpose was confirmed by observations made during a second visit to China, and on his return to England he applied himself in earnest to making the necessary preparations. Having succeeded on the death of his father to a large property, he bought and equipped a yacht, the "Royalist," of 140 tons burden, and for three years tested its capacities and trained his crew of twenty men, chiefly in the Mediterranean. At length, on October 27, 1838, he sailed from the Thames on his great adventure. On reaching Borneo, after various delays, he found the Rajah Muda Hassim, uncle of the reigning sultan, engaged in war in the province of Sarawak with several of the Dyak tribes, who had revolted against the sultan. He offered his aid to the rajah; and with his crew, and some Javanese who had joined them, he took part in a battle with the insurgents, and they were defeated. For his services the title of Rajah of Sarawak was conferred on him by Muda Hassim, the former rajah being deprived in his favour. It was, however, some time before the sultan could be induced to confirm his title (September 1841). During the next five years Rajah Brooke was engaged in establishing his power, in making just reforms in administration, preparing a code of laws, and introducing just and humane modes of dealing with the degraded subjects of his rule. But this was not all. He looked forward to the development of commerce as the most effective means of putting an end to the worst evils that afflicted the archipelago; and in order to make this possible, the way must first be cleared by the suppression, or a considerable diminution, of the prevailing piracy, which was not only a curse to the savage tribes engaged in it, but a standing danger to European and American traders in those seas. Various expeditions were therefore organized and sent out against the marauders, Dyaks and Malays, and sometimes even Arabs. Captain Keppel, and other commanders of British ships of war, received permission to co-operate with Rajah Brooke in these expeditions. The pirates were attacked in their strongholds, they fought desperately, and the slaughter was immense. Negotiations with the chiefs had been tried, and tried in vain. The capital of the sultan of Borneo was bombarded and stormed, and the sultan with his army routed. He was, however, soon after restored to his dominion. So large was the number of natives, pirates and others, slain in these expeditions, that the "head-money" awarded by the British Government to those who had taken part in them amounted to no less than £20,000. In October 1847 Rajah Brooke returned to England, where he was well received by the Government; and the Corporation of London conferred on him the freedom of the city. The Island of Labuan, with its dependencies, having been acquired by purchase from the sultan of Borneo, was erected into a British colony, and Rajah Brooke was appointed Governor and commander-in-chief. He was also named consul-general in Borneo. These appointments had been made before his arrival in England. The university of Oxford conferred on him the honorary degree of D.C.L., and in 1848 he was created K.C.B. He soon after returned to Sarawak, and was carried thither by a British man-of-war. In the summer of 1849 he led an expedition against the Seribas and Sakuran Dyaks, who still persisted in their piratical practices and refused to submit to British authority. Their defeat and wholesale slaughter was a matter of course. At the time of this engagement Sir James Brooke was lying ill with dysentery. He visited twice the capital of the sultan of Sala, and concluded a treaty with him, which had for one of its objects the expulsion of the sea-gypsies and other tribes from his dominions. In 1851 grave charges with respect to the operations in Borneo were brought against Sir James Brooke in the House of Commons by Joseph Hume and other members, especially as to the "head-money" received. To meet these accusations, and to vindicate his proceedings, he came to England. The evidence adduced was so conflicting that the matter was at length referred to a Royal Commission, to sit at Singapore. As the result of its investigation the charges were declared to be "not proven." Sir James, however, was soon after deprived of the governorship of Labuan, and the head-money was abolished. In 1867 his house in Sarawak was attacked and burnt by Chinese pirates, and he had to fly from the capital, Kuching. With a small force he attacked the Chinese, recovered the town, made a great slaughter of them, and drove away the rest. In the following year he came to England, and remained there for three years. During this time he was smitten with paralysis, a public subscription was raised, and an estate in Devonshire was bought and presented to him. He made two more visits to Sarawak, and on each occasion had a rebellion to suppress. He spent his last days on his estate at Burrator in Devonshire, and died there, June 11, 1868. Notwithstanding differences of opinion with regard to some of Sir James Brooke's proceedings, it is not to be denied that he was a man of the highest personal character. In his public conduct he was undoubtedly actuated by a noble ambition, and he displayed rare courage both in his conflicts in the East and under the charges advanced against him in England. His *Private Letters* (1838 to 1853) were published in 1853. Portions of his *Journal* have also been edited by Captains Mundy and Keppel.

BROOKES, Joshua, English anatomist, was born in 1761. At a very early age he devoted himself to medical science, and attended the lectures of the most eminent surgeons in London and Paris. After he had completed his studies, he began to teach anatomy and physiology, and continued to do so during forty years of his life, training no fewer than 5000 students, many of whom afterwards became famous in different parts of the world. His museum, which contained specimens not only of human and comparative anatomy, but also of natural history in all its branches, was arranged on a system combined from the various methods of Cuvier, Blumenbach, Linnæus, and other naturalists, and cost its proprietor about £30,000. Many of his treatises are printed in the *Transactions* of the various scientific societies of which he was a member. He died suddenly at London, January 10, 1833.

BROOKLYN, a city of the United States of North America, capital of King's County, New York, is situated on the western end of Long Island, immediately opposite the city of New York, from which it is separated by the East River, an arm of the sea, about three-quarters of a mile in breadth. Lat. 40° 41′ N.; long. 73° 59′ W. The city is of very considerable extent, measuring in greatest length

about 7¾ miles, and in greatest breadth about 5 miles; it is 22 miles in circuit, and covers a superficial area of 13,337 acres, or close upon 21 square miles. From Hunter's



Plan of Brooklyn.

Point to Bay Ridge it has a river frontage of nearly nine miles. The ground on which the city is built exhibits considerable inequalities of surface, and thus increases the picturesqueness of its appearance, while the practical disadvantages of such a site have been overcome by skilful engineering. The streets, with the exception of Fulton Street, the principal thoroughfare, are generally straight, have a width of from 60 to 100 feet, and cross each other at right angles. Chief among the public buildings are the city-hall (an edifice of white marble dating from 1845–6), the county court-house (erected in 1862), the county jail (1837), the penitentiary, the state arsenal, and the city hospital. Besides the last-mentioned institution the benevolent establishments of Brooklyn include the Long Island College Hospital, St Mary's and St Peter's hospital, the female orphan asylum, the marine hospital, the Graham institution for the relief of aged women, and numerous other charities. The churches number between 200 and 300, many of them are beautiful buildings, but none claim special notice except the new Roman Catholic Cathedral, which is only rivalled by the corresponding building in New York. Of literary and artistic institutions the most remarkable are the Mercantile Library (dating from 1857), the Brooklyn Institute (founded by Augustus Graham), the Long Island Historical Society, the Art Association, the Academy of Design, the Academy of Music, and the Philharmonic Society. There are three theatres, and an opera house, which dates from 1862. The educational establishments comprise the Packer Collegiate Institute (founded in 1853) for female education, the Polytechnic Institute for boys (started in 1854), the Adelphi Academy for both sexes (founded in 1863), the Roman Catholic College of St John, upwards of fifty public grammar and primary schools, and numerous private institutions. Though Brooklyn in some measure serves as a suburb of residence to New York, and many of its inhabitants carry on their business in the larger city, its own industrial and commercial activity is very great. It has flour-mills, sugar-refineries, lager-beer breweries, distilleries, tobacco factories, and chemical works; and manufactures steel, brass, and copper wares, engines, machinery, and printing-presses. The grain trade is of enormous extent, the warehouses being capable of holding about 12,000,000 bushels; and sugar, coffee, oil, hides, and wool are also largely imported. Most of the river frontage is lined with basins, wharves, and docks, the most important being the Atlantic dock (constructed about 1846) with an area of 40 acres, the Erie basin of 60 acres, the Brooklyn basin of 40 acres, the Wallabout basin, and the United States navy yard. This last occupies a total area of 144 acres, and has extensive wharfage, and a dry dock, built of granite, at a cost upwards of $2,113,000. The city is supplied with water by an elaborate system of reservoirs, of which the most distant is 19 miles away in the vicinity of Hempstead. Its principal pleasure ground is Prospect Park, which embraces more than 600 acres, partly covered with forest trees. A lake of 50 acres is being excavated, and there is a large well 60 feet in diameter, which will furnish the necessary water to keep it fresh. Washington Park, on the site of ancient fortifications, is also a pleasant spot, and there are various other open grounds throughout the city. At the west end is situated the well known Greenwood cemetery, which contains about 520 acres of finely-varied ground, a good part of which is still adorned with natural wood.

The traffic of the city is facilitated by tramway lines; and its conection with New York, which has hitherto been dependent on steam-boat ferries, is to be rendered more convenient by a large bridge in course of construction. This bridge, which crosses the East River near its entrance into New York Bay, is 85 feet wide, and has a river span of 1596 and a total length of 5989 feet. The total cost is estimated to exceed $13,000,000.

The first settlement of Brooklyn, or as it was formerly called Breuckelen, dates from 1636, when a few Walloon colonists took up their residence on the spot that still bears the name of Wallabout (Waalbogt or Walloons' Bay). English and Dutch settlers followed; and in 1667, a patent or charter was granted to the town by Governor Richard Nicolls. The first church had been erected the previous year. In 1698 the population only amounted to 509 persons, of whom sixty-five were slaves. In 1776 the site of the present town was the scene of the battle between the Americans and British, which is usually known as the battle of Long Island. In 1816 Brooklyn was incorporated as a village, and in 1834 it became a chartered city. Williamsburg was founded by Richard W. Woodhull, in the early part of the present century; it attained the rank of a village in 1827, and was recognized as a city in 1851. The population of Brooklyn was in 1800, 3298; in 1820, 7175; in 1830, 15,292; in 1840, 36,233; and in 1850, 96,850. In 1855 the number of inhabitants within the new boundaries was 205,250, of whom 48,367 belonged to Williamsburg; in 1860 this had increased to 266,661, and in 1870 to 396,099, and now (1876) it is estimated at 500,000. (See Stile's *History of the City of Brooklyn*, 3 vols., 1867–70.)

BROOKS, Charles Shirley, an English novelist, and dramatic and miscellaneous writer, was born in 1815. He was the son of an eminent London architect, and received his education at a public school in the city. Applying himself to the study of law, he passed the usual examination for admission; but instead of pursuing further the professional path, he turned aside and began to feel his way towards the broader field of literature. He wrote, sometimes alone, sometimes in conjunction with others, slight dramatic pieces of the burlesque kind, and became a newspaper reporter. In this capacity he was for many years engaged on the *Morning Chronicle*. For the same paper he afterwards undertook to write the parliamentary summary, and was appointed special commissioner to carry out investigations on the subject of labour and the poor. For this purpose he travelled in Southern Russia, Egypt, and Syria; the results of his inquiries appearing first in the form of letters to the editor, and afterwards in a separate volume, under the title of *The Russians of the South* (1856). Brooks was for many years on the staff of the *Illustrated London News*, contributing the weekly article on the politics of the day, and the two series entitled "Nothing in the Papers" and "By the Way," besides other occasional pieces. In 1854 he joined the staff of

Punch, and noteworthy among his numerous contributions were the weekly satirical summaries of the parliamentary debates, entitled "The Essence of Parliament." His long service as newspaper reporter gave him special aptitude for this playful parody. In 1870, on the death of Mark Lemon, "dear old Shirley," as his friends used to call him, was chosen to succeed to the editorial chair. He added to his reputation by several good novels, the first of which, *Aspen Court*, was published in 1855. It was followed by *The Gordian Knot* (1860), *The Silver Cord* (1861), and *Sooner or Later* (1868). Brooks was a great letter-writer, deliberately cultivating the practice as an art, and imitating the style in vogue before newspapers and telegraphs suppressed private letters. He had an astonishing memory, was brilliant as an epigrammatist, and was a great reader, and a most genial and admirable companion. Though he nearly reached his sixtieth year, he retained all the charm of youthful freshness and brightness. He was in his element with a group of children, reading to them, sharing their fun, and always remembering the birthdays. He died in London, February 23, 1874. His remains were interred, near those of his friends Leech and Thackeray, in Kensal Green cemetery. As a novelist Shirley Brooks holds a high rank, but not the highest. His novels probably suffered in some respects from the manner of their production, the slow piece-meal writing for periodical literature. But they possess qualities of an order which will save them from the swift oblivion that overtakes so many books of their class. He shows in them a large knowledge of men, especially of Londoners, a fair acquaintance with the world of books and the world of art, a fertile imagination, and much critical acumen. And these qualities are set off to the best advantage by the charm of an admirably vigorous and polished style. In this respect, and in the force of his refined satire, he bears some likeness to his greater friend, the author of *Vanity Fair*.

BROOME, William, the coadjutor of Pope in translating the *Odyssey*, was born at Haslington in Cheshire, in 1689. He was educated upon the foundation at Eton, and was captain of the school a whole year, without any vacancy occurring by which he might have obtained a scholarship at King's College. Being by this delay superannuated, he was sent to St John's College by the contributions of his friends, and obtained a small exhibition there. His fondness for metrical composition was then such that his companions familiarly called him "Poet." He appeared early in the world as a translator of the *Iliad* into prose, in conjunction with Ozell and Oldisworth, the translation being superior, in Toland's opinion, to that of Pope. Broome was introduced to Pope, who was then visiting Sir John Cotton at Madingley, near Cambridge, and gained so much of his esteem that he was employed to make extracts from Eustathius for the notes to the translation of the *Iliad*, and in the volumes of poetry published by Lintot, commonly called *Pope's Miscellanies*, many of his early pieces were inserted.

When the success of the *Iliad* gave encouragement to a version of the *Odyssey*, Pope, weary of the toil, called Fenton and Broome to his assistance; and taking only half the work upon himself, divided the other half between his partners, giving four books to Fenton and eight to Broome. To the lot of Broome fell the second, sixth, eighth, eleventh, twelfth, sixteenth, eighteenth, and twenty-third, together with the burden of writing all the notes. The price at which Pope purchased this assistance was £300 paid to Fenton and £500 to Broome, with as many copies as he wanted for his friends, which amounted to £100 more. The payment made to Fenton is known only by hearsay; Broome's is very distinctly told by Pope in the notes to the *Dunciad*. It is evident that, according to Pope's own estimate, Broome was unfairly treated. If four books could merit £300, eight, and all the notes, equivalent at least to four more, had certainly a right to more than £600. Broome probably considered himself as injured, for he always spoke of Pope as too much a lover of money, and Pope pursued him with avowed hostility. He not only named Broome disrespectfully in the *Dunciad*, but quoted him more than once in the *Bathos*, as a proficient in the art of sinking. It has been said that they were afterwards reconciled, but their peace was probably without friendship. Broome afterwards published a *Miscellany of Poems*. He never rose to very high dignity in the church; he became rector of Sturston in Suffolk, where he married a wealthy widow; and afterwards, when the king visited Cambridge, in 1728, he was made doctor of laws. In the same year he was presented to the rectory of Pulham. Towards the close of his life he amused himself with translating some of the Odes of Anacreon, which he published in the *Gentleman's Magazine*, under the name of Chester. He died at Bath in 1745. (See T. W. Barlow, *Memoir of William Broome*, 1855.)

BROSELEY, formerly Burwardesley, a market-town on the Severn, in the county of Shropshire, 146 miles from London. It is a place of considerable trade in iron, having near it productive mines of that mineral, as well as of coal. There are also manufactories of tobacco-pipes, bricks, and tiles. Population of parish in 1871, 4639.

BROSSES, Charles de, first president of the parliament of Burgundy, was born at Dijon in 1709. He studied law with a view to the magistracy, but the bent of his mind was towards literature and the sciences. He travelled through Italy in 1739 in company with his friend M. de Sainte-Palaye; and on his return to France published his *Lettres sur l'État Actuel de la Ville Souterraine d'Herculaneum*, Dijon, 1750, 8vo, which was the first work upon that interesting subject. A collection of letters, written during his Italian tour, entitled *Lettres Historiques et Critiques*, in three vols. 8vo, was published at Paris after his death. In 1760 he published a dissertation, *Sur le Culte des Dieux Fétiches*, 12mo, which was afterwards inserted in the *Encyclopédie Méthodique*. At the solicitation of his friend Buffon, De Brosses undertook his *Histoire des Navigations aux Terres Australes*, which was published in 1756, in two vols. 4to, with maps. It was in this work that M. de Brosses first laid down the geographical divisions of Australasia and Polynesia, which were afterwards adopted by Pinkerton and succeeding geographers. In 1765 appeared his *Traité de la Formation Mécanique des Langues*, a work distinguished by much research, and containing an admirable exposition of the purely empirical theory of the origin of language. Full recognition of its merits will be found in Dr Tylor's work, *Primitive Culture*. M. de Brosses had been occupied, during a great part of his life, on a translation of Sallust, and in attempting to supply the lost chapters in that celebrated historian. At length in 1777, he published *L'Histoire du Septième Siècle de la République Romaine*, 3 vols. 4to, to which is prefixed a learned life of Sallust, reprinted at the commencement of the translation of that historian by De Lamalle. These literary occupations did not prevent the author from discharging with ability his official duties, nor from carrying on a constant and extensive correspondence with the most distinguished literary characters of his time. In 1758 he succeeded the Marquis de Caumont in the *Académie de Belles Lettres*; but he was never admitted a member of the French Academy, in consequence, it is said, of the opposition of Voltaire.

Besides the works already mentioned, he wrote several memoirs and dissertations in the collections of the Academy of Inscriptions, and in those of the Academy of Dijon. He also contributed various articles to the *Dictionnaire Encyclopédique*, on the subjects of grammar, etymology,

music, &c., and he left behind him several MSS., which were unfortunately lost during the revolution. He died in 1777.

BROUGHAM, HENRY, first Lord Brougham and Vaux, man of letters, man of science, advocate, orator, statesman, and Lord High Chancellor of England, was born at Edinburgh on the 19th September 1778, and died at Cannes in France on the 7th May 1868. During a great portion of a life extended to the unwonted term of ninety years, but especially in the third and fourth decades of the present century, from 1820 to 1840, no Englishman in any civil career played so conspicuous a part in public affairs or enjoyed so wide a fame as Henry Brougham. His indomitable energy, his vehement eloquence, his enthusiastic attachment to the cause of freedom, progress, and humanity, to which he rendered so many signal services, caused him to be justly regarded as one of the most extraordinary and illustrious men of his age and of his country. He brought to all he undertook a vigour and variety of intellect almost unparalleled; for his ambition was to excel in all things, and he seemed to aspire to universal fame. "There go," said Mr Rogers, as he drove off one morning from Panshanger, "Solon, Lycurgus, Demosthenes, Archimedes, Sir Isaac Newton, Lord Chesterfield, and a great many more in one post-chaise." No man ever commanded with more effect the applause of listening senates, or could better rouse the depths of popular enthusiasm. His boundless command of language, his audacity, his memory stored with every sort of knowledge, his animal spirits and social powers, gave him the lead everywhere, and he was not slow to take advantage of his splendid talents and acquirements in every mode of life. His striking and almost grotesque personal appearance added to the effect of his voice and manner;—a tall disjointed frame, with strong bony limbs and hands, that seemed to interpret the power of his address; strange angular motions of his arms; the incessant jerk of his harsh but expressive features; the exquisite modulations of his voice, now thundering in the loudest tones of indignation, and now subdued to a whisper which penetrated to the very walls of the House of Commons and riveted the attention of the audience; a power of mingling tenderness and scorn, argument and invective, in sentences which rose in accumulated involutions, but righted themselves at last, all contributed to give him the magical influence which a great actor exerts over a crowded theatre. Yet in the midst of all his triumphs, the companions of his early life and those who were best acquainted with his character, knew that his extraordinary gifts and powers did not include all the elements of true greatness. He wanted that moral elevation which inspires confidence and respect, and which is even more essential than genius to the highest achievements and the most lasting fame. At times his eccentricity rose to the verge of insanity, as if the reins by which he guided his fiery temper had slipped from his hand. At the bar there were greater and better advocates; on the bench there were more sure and learned judges; in science he made no real discoveries; in letters, notwithstanding the prodigious activity of his pen, he has left no work of lasting celebrity; and although as an orator he was in his best days unequalled, he himself outlived the evanescent glories of his eloquence. Hence it has come to pass, that within fifty years of his most brilliant period, and within ten years of his death, the figure of Lord Brougham has already become somewhat indistinct. The generation which was fascinated by his eloquence and amused by the endless coruscations and evolutions of his character is passing away, and it has become a task of difficulty to preserve a faithful record of so strange and wonderful a phenomenon. That, however, which remains, and must ever remain as the noblest memorial of his life, is his unvarying devotion to the progress of liberal opinions, to the reform of the law, to popular education, to the emancipation of the negro race from slavery, and to the maintenance of peace. In this sense, he was, as he was once portrayed by an accomplished caricaturist of the day, a citizen of the world. Of every human right, Brougham was a champion; of every human wrong, an avenger.

We shall not attempt in this notice of his life to follow the innumerable incidents of his long and varied career, or to enumerate the speeches and writings which he threw off like sparks on every imaginable occasion. Our object is rather to convey to the reader a just impression of the man, as he appeared to those who knew him as he was, and who still recall the transcendent effects of his energy. Lord Brougham has been unfortunate in his biographers. The memoir of him prepared by Lord Campbell, and published after the death of the author and of the subject of it, is written in a carping and derisive tone, unworthy of a distinguished rival. Lord Brougham's autobiography, which also appeared after his death, was begun when he had passed his eightieth year; his faculties were impaired, his memory was failing, and the work is full of inaccuracies, which his successors were not authorized to correct. Yet we are indebted to it for some interesting particulars of his early life, which no one but himself could have preserved.

In his later years, after Lord Brougham had taken his seat in the House of Peers, he was wont to trace his paternal descent to Udardus de Broham, in the reign of Henry II., and some memorials of that doughty crusader still decorate the baronial hall at Brougham. He claimed, besides, an infusion of pure Norman blood from Harold, Lord of Vaux in Normandy, whose title he added to his own. But these were the delusions of an enthusiastic mind. No real connection has been established between the ancient lords of Brougham Castle, whose inheritance passed by marriage from the Viponts into the family of the De Cliffords, and the Broughams of Scales Hall, from whom the chancellor was really descended. Brougham Hall was purchased from one James Bird by Brougham's great-granduncle, who left it to his grandfather, an active attorney and agent to the duke of Norfolk for his grace's Cumberland property. His father, Henry Brougham, was sent to Eton, and afterwards travelled on the Continent. The sudden death of a young lady to whom this gentleman was about to be married, deeply affected him: he started in 1777 for a short tour in Scotland, but as fate would have it he never recrossed the border or revisited Brougham. In Edinburgh he took lodgings at the house of Mrs Syme, the widow of a clergyman, and a sister of Principal Robertson, the historian. This lady had a daughter of singular beauty and merit. Mr Brougham fell in love with her and agreed to settle in Edinburgh as a condition of obtaining her hand. They were married by Dr Robertson, and in the following year the eldest son, the illustrious subject of this notice, was born at No. 21 St Andrew Square. No feeling in life was more deeply rooted in the heart of Lord Brougham than his intense affection and veneration for his admirable mother. He repaid her early care and judicious guidance by the most ardent and unvarying devotion. He willingly laid all the triumphs of his career at her feet; and she lived to see him attain the proudest heights of fame and power. Nor was he less attached to the memory of his great uncle, the principal. To his dying day he would retrace with affectionate emotion the influence that accomplished scholar and excellent man had upon his own education. He well remembered his person and his precepts, for Dr Robertson only died in 1793, and nearly seventy years afterwards Lord Brougham, presiding over the Social Science meeting at Glasgow, was touched by

hearing a "paraphrase," by his great kinsman, sung in Glasgow cathedral, the authorship of which was probably known only to himself. His parentage on his mother's side being Scotch, and Scotland the place of his birth and education—and, indeed, of his entry into life—he naturally retained many Scottish peculiarities of manner and intonation; yet Brougham was not a Scotchman, he was somewhat eager to throw off his Scottish character, and he said in after life that there was no place he should visit so unwillingly as Edinburgh.

Early life

From his earliest age Brougham showed signs of extraordinary talents and energy. His mother averred that he spoke distinctly several words when he was eight months and two weeks old. In his cradle he was the terror of his nurses, and as he grew older his grandmother compared him to the admirable Crichton from his excelling in everything he undertook. When barely seven he was sent to the High School of Edinburgh, where he gained a triumph over Luke Fraser, his tutor, by successfully justifying the use of some Latin words which Fraser had condemned in an exercise, and in August 1791, when he was not yet thirteen, he left the school as *dux*, or head of the fifth form, taught by the headmaster, Dr Adam. He entered the university of Edinburgh in the winter of 1792, and in addition to the study of Greek under Professor Dalzell, he applied himself to the natural sciences under Professor Playfair, and especially to mathematics. At twelve one of his cousins met him with a huge quarto under his arm, which turned out to be Laplace's *Mécanique Céleste*, in French. In the mathematical class he hit upon the binomial theorem before he had been taught it; and he was soon conversant with the *Principia* of Newton. It was characteristic of his astonishing memory that he carried with him through life all he had learned in boyhood. We have seen him in later years vary the monotony of a legal argument by working a problem in algebra, or exchanging a Greek epigram with Lord Wellesley, in the midst of grave debates of politics or of laws. In 1794 he set to work to master the fluxional calculus; and in the following year he sent a paper to the Royal Society on some new phenomenon of light and colours, which was printed in the *Transactions* of that learned body. A paper on porisms was published in the same manner in 1798, and in 1803 his scientific reputation was so far established that he was elected a fellow of the society. But these efforts were more remarkable for their precocity than for their novelty. In spite of his taste for mathematical reasoning Brougham's mind was not an accurate or exact one; and his pursuit of the physical sciences was rather a favourite recreation than a solid advantage to him. He continued his experiments in optics through life, however, and would sometimes impart observations, which he took for discoveries, to the French Academy of Science. An enthusiastic discourse on Newton and the Newtonian philosophy was written by him in his eighty-fifth year, when a statue of the great philosopher was erected at Grantham, and at that age he was still fond of commenting upon the *Principia*.

But whilst Henry Brougham was following lectures in every branch of knowledge at the university, his inherent animal spirits and sociable nature made him the ringleader of the gayest and wildest youths of the time. Practical jokes, wrenching knockers, braving the watch, and wasting the small hours of the night, were pastimes as familiar to him as the gravest discussions. "Looking back," says he, in his *Memoirs*, "to these pranks reminds me of the inexhaustible fund of spirits one possessed, and how that capital foundation of never-tiring energy and endless restlessness enabled some of us to work on with unfailing strength to the end of life; and even now, writing at nearly ninety years of age, I can recall them—not boys' but young men's freaks—with pleasure and even exultation; yet I agree with the old beggar Ochiltree, in the best of all Scott's works, saying—'Aye, aye! they were daft days thae, but they were a' vanity and waur.'" The spirit of these "daft days," these mad-cap hours, clung to Brougham through life; and long after he had held his great seal of England, perhaps while he held it, he was just as ready to play his part in scenes of the wildest merriment as he had been at the university.

As early as 1792 he founded a debating society of a very juvenile character, to which several persons afterwards distinguished in life belonged. This society, however, subsequently merged in the "Speculative Society," which had a hall and library of its own in the college. Here Brougham, Horner, Jeffrey, Cockburn, Murray, and Moncreiff tried their early powers, and gave the promise of that eloquence which eventually placed them all in Parliament or on the bench of justice. Brougham surpassed them all, not, indeed, in depth of knowledge or soundness of reasoning, but in the astonishing flow of his language, his readiness in reply, the grace of his elocution, and his withering gift of sarcasm and ridicule. Of all the remarkable powers he possessed that of oratory was unquestionably the first. Conscious of his natural strength and of the advantages to be derived from this faculty in a country which is largely governed and swayed by rhetoric, he applied himself with peculiar zeal to the *art* of public speaking. He made himself perfectly conversant with the great masterpieces of ancient eloquence, which he knew to a great extent by heart; he ever maintained that the highest effects of the orator could only be achieved by diligent preparation and constant study; he bestowed extreme care upon the modulation of his voice, which was one of extraordinary compass and strength; even his gestures and attitudes were the result of thought, and it was remarked that in concluding the elaborate peroration of his speech on the queen's trial, he assumed the majestic bearing with which a minister of the Scottish Church invokes the blessing of God in dismissing his congregation. Both by study and by practice, then, oratory was his chief art, and he continued through life to cultivate it with the enthusiasm of an actor, who never entirely attains to the fulfilment of his own ideal. No doubt, in the resistless torrent of his invective, in appeals to the passions of his audience, in the rapid and lucid exposition of facts, in the skilful arrangement of his discourse, which was highly artificial, and in the power of wielding enormous and intricate sentences, Brougham was unrivalled. He entered the House of Commons, as we shall presently see, soon after the voices of Pitt and Fox had been hushed for ever. Except Canning, there was no one in Parliament who could be compared to Brougham, and he rapidly rose to a height of distinction which became at one moment supremacy. Yet on looking back, even to the most celebrated and successful of his efforts, subsequently revised and published by himself, little remains which can lay any claim to the dignity of classic eloquence. Notwithstanding Lord Brougham's study and enthusiastic admiration of Demosthenes, nothing was more unlike the stern simplicity and grandeur of the great Athenian—"*Densus, et brevis, et semper instans sibi*"—than the declamation of Lord Brougham. The force of the current was wasted in a flood which overleapt its banks and broke its barriers. The effect was more intense than permanent. Even in the judgment of his own contemporaries, Canning surpassed him in wit; Plunket in felicity of diction; Lyndhurst in terseness, policy, and cogency of argument; Ellenborough in dignity: but none of them possessed his marvellous versatility, and it seemed as if he had borrowed from each of these great speakers a share in some gift, which they possessed in higher perfec-

Oratorical powers

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tion than himself. Of all the branches of human knowledge to which Brougham directed his attention, and in which he attained to more or less proficiency, the study of the law was the least congenial to him. He speaks of it in early life as "the cursedest of all cursed professions," and even in 1808, when he had come to England and acquired a certain degree of fame, he writes to Lord Grey: "Odious as that profession is (as God knows there are few things so hateful), I am quite clear that it would be folly in me to neglect so certain a prospect." He added that he was setting out on the Northern Circuit with too slender a provision of law,—his stock of practice being so small that he had never yet seen a *nisi prius* trial,—but thought he might push through the thing with a little presence of mind and quickness. Fortunately for his future career, he had followed for two years the lectures of the professor of civil law in the university of Edinburgh; and, as Lord Campbell admits, so far *legalized* his mind that he had gained a considerable insight into both Roman and feudal jurisprudence. These seeds of law, implanted in a powerful intellect, gave him a breadth of view not always combined with the technicalities of the English bar.

On the 23d May 1800 he was admitted to the Faculty of Advocates. It does not appear that he ever held a brief in the Court of Session, but he went a circuit or two, where he defended or prosecuted a few prisoners, and played a series of tricks on the presiding judge, Lord Eskgrove, which almost drove that learned person to distraction. The Scottish bar, however, as he soon perceived, offered no field sufficiently ample for his talents and his ambition. He resolved to transfer himself to London. He had already appeared as junior counsel in a Scotch appeal to the House of Lords. In 1803 he was entered at Lincoln's Inn, and on the 22d November 1808 he was called to the English bar by that learned society. It is a curious indication of the importance already attached to him as a party man, that the Tory attorney-general and the solicitor-general of the day thought it worth while to come down to Lincoln's Inn to endeavour to oppose his special call, which had been asked for, but was defeated by a single vote. He was called in the ordinary course in the ensuing term.

dinburgh Review.

In this interval of time, however, he had struck a fresh vein which ensured to him power, popularity, celebrity, and for the time a subsistence. The *Edinburgh Review* was founded in the autumn of 1802, under circumstances which have often been related, by the young and aspiring lights of the northern metropolis. The polished style and judgment of Jeffrey, the wit of Sydney Smith, the wisdom of Horner, were suddenly brought to bear on the literature and politics of the day, and amongst them all Brougham was the most ready, the most versatile, the most satirical, and eager to fly at any game which might be on foot. To the first four numbers of the *Review* Brougham contributed twenty-one articles; to the first twenty numbers eighty articles, wandering through every imaginable subject—science, politics, colonial policy, literature, poetry, surgery, mathematics, and the fine arts. The article on Lord Byron's *Hours of Idleness*, which stung the poet into a satirist, and gave the world *English Bards and Scotch Reviewers*, was attributed to his pen; and Lord Cockburn used to relate that on one occasion Brougham wrote off an entire number, including one article on the operation of lithotomy and another on the music of the Chinese. What, however, was of more importance to the youthful author and to the world, was that Brougham stood henceforth indissolubly pledged to the cause of the Liberal party, and to those principles of progress and reform to which he was destined to render so many signal services. The *Edinburgh Review* is the standard of that cause, and Brougham never rested until he had planted it on the loftiest battlements of the fortress. The prodigious success of the *Review*, and the power he was known to wield in it, made him a man of mark from his first arrival in London. He was welcomed at Holland House. He obtained the friendship of Lord Grey and the leading Whig politicians. His wit and gaiety made him an ornament of society, and he sought to extend his literary reputation by the publication of an elaborate work on the colonial policy of the empire. But his hopes of obtaining a seat in Parliament were not yet realized. He was still eating his commons at Lincoln's Inn. He was still in search of a career. Thus it fell out that, in 1806, Mr Fox being then Secretary of State, he was appointed secretary to a mission of Lord Rosslyn and Lord St Vincent to the court of Lisbon, with a view to counteract the anticipated French invasion of Portugal. The mission lasted two or three months; it led to no results. Brougham came home out of humour and out of pocket; and meantime the death of Mr Fox put an end to the hopes of the Whigs and to the broad-bottomed administration. The party to which Brougham had attached himself remained out of office for three-and-twenty years.

Remo. Londo.

Brougham was disappointed by the abrupt fall of the ministry, and piqued that his Whig friends had not provided him with a seat in Parliament, the more so as some of his early friends and rivals were already launched on their political career. Nevertheless, he exerted his pen with prodigious activity during the election of 1809; and Lord Holland declared that he had filled the booksellers' shops with articles and pamphlets. The result was small. No seat was placed at his own disposal. He was too poor to contest a borough; and Perceval and Eldon obtained a majority greater than the majorities of Addington or Pitt. Fortunately for Brougham two questions at this time arose, which gave him a strong hold on the feelings and commercial interests of the country; and he was not slow to take advantage of them and lend them all the support of his energy and genius. When he entered public life the abolition of the slave-trade was well-nigh carried by the untiring exertions of Wilberforce, Thornton, Clarkson, Macaulay, and others. An immense organization had been formed, more especially by the Quakers and other nonconformists, to bring the whole force of public opinion, awakened by the call of humanity and justice, to bear upon the horrors of a system which was still defended by the West India interest and the Government. Brougham allied himself to the leaders of this movement, and he remained through life not only faithful, but passionately attached to the cause. He combated, in and out of Parliament, every attempt to elude the restrictions on the trade in man. One of the first measures he carried in the House of Commons was a bill to make the slave-trade felony. He laboured incessantly to induce foreign countries to abolish the abhorred traffic, and he had at length the happiness, as Chancellor of England, to take a part in the final measure of negro emancipation throughout the British colonies. These services endeared him to a class of highly conscientious and influential persons, with whom he might not otherwise have been closely connected, and their support was of no small effect on the greatest triumph of his life, his election for the county of York in 1830.

Slave-trade.

Although till 1808 Brougham had no practice at the English bar, he had argued some Scotch appeals in the House of Lords and some prize cases at the "Cock-pit." He had acquired some knowledge of international law, and some experience of the prize courts. This circumstance probably led to his being retained as counsel for the Liverpool merchants who had petitioned both Houses of Parliament against the Orders in Council, framed in retalia-

Orders in Council.

tion for the Berlin and Milan decrees. Brougham conducted the lengthened inquiry which took place at the bar of the House, and he displayed on this occasion a mastery over the true principles of political economy and international law which at that time no one else possessed. It seems incredible (though even now the delusion is not entirely dissipated) that the Government of a great commercial nation should ever have thought that one of the most effectual and essential modes of carrying on war and destroying an enemy is to shut out the trade of neutrals, not perceiving that such measures react with at least equal force against ourselves, and destroy the very sinews by which the burden of war can be sustained. The trade of the country was in truth suffering more from these fatal restrictions than from the war itself; and nothing in the whole collection of Lord Brougham's harangues is more forcible or more ably reasoned than the speeches in which he described those sufferings, and denounced the cause of them.

Nevertheless, in 1808, he was unsuccessful. Neither the evidence taken during a six months' inquiry nor the eloquence of the impassioned advocate prevailed. It was not until 1812, when Brougham was himself in Parliament, that he resumed his attack on the Orders in Council with increased authority and vigour, aided by Mr Baring, and still more, perhaps, by the peril and disgrace of the quarrel with America, and he ultimately conquered. No answer was made to his great speech on that occasion, except an intimation from the Treasury bench that the Orders in Council would be revoked. Of this great triumph Brougham afterwards said: "It was second to none of the efforts made by me, and not altogether without success, to ameliorate the condition of my fellow-men. In these I had the sympathy and aid of others, but in the battle against the Orders in Council I fought alone."

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tary

It was considered imprudent and impossible that a man so gifted and so popular as Brougham had now become should remain out of Parliament, and by the influence of Lord Holland, the duke of Bedford was induced to return him to the House of Commons for the borough of Camelford. He took his seat early in 1810, having made a vow that he would not open his mouth for a month. The vow was kept, but kept for that month only. He spoke on the fifth March in condemnation of the conduct of Lord Chatham at Walcheren, and he went on speaking for the rest of his life. In four months, such was the position he had acquired in the House that he was regarded as a candidate for the leadership of the Liberal party, then in the feeble hands of George Ponsonby. Some little time before a squib of infinite drollery was published in the *New Whig Guide*, by Lord Palmerston, under the significant title of "Trial of Harry Brougham for Mutiny." The mutiny consisted in his calling the Right Honourable George Ponsonby an "old woman." When the negotiation took place in 1812 between the Prince Regent and Lords Grey and Grenville for the formation of a Whig Government, it was expected that the presidentship of the Board of Trade would be accepted by Brougham, who was not unwilling to quit the bar altogether for political office. But this gleam of parliamentary success and official anticipation soon vanished. The Tories continued in power. Parliament was dissolved. Camelford had passed into other hands. Brougham was induced to stand for Liverpool with Mr Creevy against Canning and General Gascoyne. The Liberals were defeated by a large majority, and what made the sting of defeat more keen was, that another seat was speedily provided for Creevy, whilst Brougham was left out in the cold. He remained out of Parliament during the four eventful years, from 1812 to 1816, which witnessed the termination of the war, and he did not conceal his resentment against the Whigs.

Brougham's position at this time was difficult and anomalous. Burning with political ambition, and conscious that he had no superior in the arena of the House of Commons, he had lost his seat in Parliament; he was distrusted and feared by some of the leading members of the Liberal party, and, as he said himself in a letter to Lord Grey, "it is their pleasure to consider me as flung overboard to lighten the ship." Yet he stood aloof, not only from the extreme views of demagogues like Hunt and Cobbett, but also from the milder radicalism of Hobhouse and Burdett. Indeed, it deserves to be remarked, that fond as Brougham was of popular applause, and deeply imbued as he was with Liberal opinions, he never condescended to flatter the Radical party or to ally himself with them: but, on the contrary, when in later years differences arose between himself and the Whigs, he leaned rather to the Conservative side, and he was uniformly opposed to any measure which might overthrow the balance of the constitution.

But in the years he spent out of Parliament occurrences took place which gave ample employment to his bustling activity, and led the way to one of the most important passages in his life. He had been introduced in 1809 by Lord Dudley and Sir William Drummond to the society of the Princess of Wales, whose house at Kensington, and afterwards at Blackheath, was the resort of the most agreeable society in London. Canning, Granville Leveson, Dudley, Rogers, and Luttrell were constantly there. But it was not till 1812 that the princess consulted him on her private affairs, after the rupture between the Prince and the Whigs had become more decided. From that time Brougham, in conjunction with Mr Whitbread, became one of the princess's chief advisers; he was attached to her service, not so much from any great liking or respect for herself, as from an indignant sense of the wrongs and insults inflicted upon her by her husband. We shall not attempt to follow the details of these deplorable transactions, which are fully related elsewhere, but one memorable scene, as related by Lord Brougham, cannot be passed over in silence. The Princess Charlotte, irritated and alarmed by her father's threats to break up her household and to marry her to the Prince of Orange, escaped in July 1814 from Warwick House, flung herself into a hackney coach in Cockspur Street, and drove to her mother's residence in Connaught Place. Mr Brougham, who was dining with a friend, was immediately sent for, and on his arrival, half asleep from fatigue, found with extreme surprise what had occurred. The duke of Sussex, the duke of York, Lord Chancellor Eldon, the bishop of Salisbury, and others subsequently arrived, but except the royal dukes, none of these personages were admitted to an audience. Brougham, a young barrister of thirty-six, became and remained the chief adviser of this young princess of eighteen, the heiress to the crown. His advice to her was, —"Return at once to Warwick House or Carlton House, and on no account pass a night elsewhere." The debate was long and painful; the grievances of the princess were numerous. At length, as day began to dawn, Brougham took her to the window, and pointing to the empty street and park, said, "In a few hours these thoroughfares will be crowded. I have only to show you from this window to these multitudes, they will rise in your behalf; Carlton House will be attacked; troops will be called out; blood will be shed; and whatever be the result, it will be known that your running away was the cause of this mischief. You would never get over it." This remonstrance prevailed, and the princess returned to Carlton House with her uncle the duke of York at five in the morning. This anecdote is so graphically told by Lord Brougham in several places that we preserve it. But it has not been corroborated by any of the other persons present; and in a letter written by Brougham himself to Earl Grey on the following day, he said nothing of this touching appeal, but relates that the princess went back because the duke of York came, armed with full powers from the Regent to fetch her away. It is not improbable that the scene thus described is apocryphal, or at least embellished by Lord Brougham's imagination, for in his later years he was apt to mistake for actual occurrences the creations of his own fancy.

Adviser of Princess of Wales.

In 1814, the Princess of Wales, having been prohibited by Queen Charlotte from attending the drawing-rooms given to the allied sovereigns on their visit to England, resolved to go abroad. This unfortunate scheme was strongly opposed by the Princess Charlotte, and not less so by Mr Whitbread and Mr Brougham. The latter addressed a letter to the Princess of Wales on the eve of her departure, in which he pointed out with great sagacity and good sense the fatal consequences of her withdrawal from England. "As long as you remain in this country," he said, "I will answer for it that no plot can succeed against you. But if you are living abroad, surrounded by the base spies and tools who will always be planted about you, ready to invent and swear as they may be directed, who can pretend to say what may happen? I declare, I do not see how a proposition hostile to your Royal Highness's marriage could be resisted if you continued living abroad." How completely these predictions were fulfilled is sufficiently known. Brougham appears to have had but little correspondence with the princess during her residence in Italy. But in 1820, when she resolved to return to England on the accession of George IV., he was sent by the Government conjointly with Lord Hutchinson, to dissuade her from that step and to offer her terms. Brougham certainly disapproved of her return; but for some mysterious reason he withheld the proposed terms of compromise until it was too late, and when they were laid before the queen at St Omer she rejected them with scorn. The death of Mr Whitbread and of the Princess Charlotte, which had occurred in the interval, had removed two important checks on the rashness of the queen; and Brougham, who had failed to prevent her from going away, was equally unable to prevent her return. It has even been surmised that, from a love of mischief and of power, he desired it.

Meanwhile Brougham had at length, in 1816, been again returned

to Parliament for Winchelsea, a borough of the earl of Darlington, and he instantly resumed a commanding position in the House of Commons. He succeeded in defeating the continuance of the income tax; he distinguished himself as an advocate for the education of the people; and on the death of Romilly he took up with ardour the great work of the reform of the law. It has taken half a century to work out the plans of these early law reformers, and the last year or two have given us a national system of education and a new judicature with an entirely new form of procedure. But not the less glorious and valuable were the services of those who first engaged in these great tasks. Nothing exasperated the Tory party more than the select committee which sat, with Mr Brougham in the chair, in 1816 and the three following years, to investigate the state of education of the poor in the metropolis. The inquiry was extended so far as to include the great collegiate foundations of Eton, Winchester, and the Charter House; and the report of the committee was attacked with great virulence by Bishop Monk in the *Quarterly Review* and by Sir Robert Peel in the House of Commons. In time, however, the exposure of abuses bore fruit, and we owe to it some of the most important improvements of the age. Brougham, however, was as far as ever from obtaining the leadership of the party to which he aspired. Indeed, as was judiciously pointed out by Lord Lansdowne in 1817, the opposition had no recognised efficient leaders; their warfare was carried on in separate courses, indulging their own tastes and tempers, without combined action. Nor was Brougham much more successful at the bar. The death of George III. suddenly changed this state of things. Queen Caroline at once, in April 1820, appointed Mr Brougham to be Her Majesty's attorney-general, and Mr Denman her solicitor-general. They immediately took their rank in court accordingly; and, indeed, this was the sole act of royal authority which marked the queen's brief and unhappy reign. In July Her Majesty came from St Omer to England; ministers sent down to both Houses of Parliament the secret evidence which they had long been collecting against her; and a bill was brought into the House of Lords for the deposition of the queen and the dissolution of the king's marriage. The long repressed spirit of opposition in the nation against a bigoted and tyrannical Government was inflamed to a conflagration by the sense of the queen's wrongs. Guilty or innocent (and no one could dispute the excessive levity of her conduct), she was regarded by the people of England as a persecuted woman, a deserted wife, an outraged mother; and these charges were brought against her by those who were guilty of far greater offences. "My mother would not have been so bad," the Princess Charlotte is reported to have said, "if my father had not been much worse." Themes such as these, worked upon by the eloquence of Brougham and the activity of the queen's friends, produced a popular commotion, which in any other country would have caused bloodshed, and perhaps revolution.

The defence of the queen was conducted by Brougham, assisted by Denman, Lushington, and Wilde, with equal courage and ability. He hurled back defiance on the prosecutors, and threatened, if driven to the last extremity, to retaliate on the person of the sovereign: though if he had set up the marriage of the Prince with Mrs Fitzherbert as a valid marriage (which it certainly was not), he would thereby have annulled the subsequent marriage of his royal client. He demolished piece by piece with merciless severity the whole fabric and tissue of Italian evidence, raked together and paid for by the Milan commission; and he wound up the proceedings by a speech of extraordinary power and effort. The peroration was said to have been written and rewritten by him seventeen times. At moments of great excitement such declamation may be of value, and in 1820 it was both heard and read with enthusiasm. But to the calmer judgment of another generation this celebrated oration seems turgid and overstrained. The truth is, that there were moments in the course of the trial when the evidence pressed so hardly on the queen that her counsel were on the point of throwing up the case. But a generous feeling, impelled by an immense popular sympathy, prevailed. It was certain the bill could never pass the House of Commons, where the same appeals might be made to a less judicial assembly. The final majority in the Lords dwindled to nine; and Lord Liverpool announced that he should not proceed with the bill.

This victory over the court and the ministry raised Henry Brougham at once to the pinnacle of fame. He shared the triumph of the queen. His portrait was in every shop window. A piece of plate was presented to him, paid for by a penny subscription of peasants and mechanics. With his wonted disinterestedness in money matters, he refused to accept a sum of £4000 which the queen herself placed at his disposal. He took no more than the usual fees of counsel, while his salary as Her Majesty's attorney-general remained unpaid, and was discharged by the Treasury after her death. But from that moment his fortune was made at the bar. His practice on the northern circuit instantly quintupled. One of his finest speeches was a defence of a Durham newspaper which had attacked the clergy for refusing to allow the bells of the churches in Durham to be tolled on the queen's death; and by the admission of Lord Campbell, a rival advocate and an unfriendly critic, he rose suddenly to a position which no man has before or since attained to in the profession. The meanness of George IV. and Lord Eldon refused him the silk gown to which his position at the bar entitled him, and for some years he led the circuit as an outer barrister, to the great loss of the senior members of the circuit, who could only be employed against him. His practice rose to about £7000 a year, but it was again falling off before he became Chancellor.

The death of Lord Castlereagh in 1822, and the advancement of Canning to the office of Foreign Secretary, materially changed the character of Lord Liverpool's Government. Canning and Brougham sat on opposite benches—the one a follower of Pitt, the other of Fox; and they were constantly pitted against each other. Sometimes their rhetorical conflicts assumed an intense violence, as when Brougham accused the minister of "the most monstrous truckling for the purpose of obtaining office that the whole history of political tergiversation could furnish." Canning indignantly exclaimed, "It is false;" and the quarrel was with some difficulty appeased, though Brougham was not supposed to be very ready to employ any weapon sharper than his tongue. But Canning and Brougham were in truth rivals rather than antagonists; and the more liberal influence of the former in the ministry had almost brought them into union upon the leading questions of the day, always excepting that of parliamentary reform. Had Canning lived and maintained himself in power, it might have fallen to his lot to carry Catholic Emancipation and a more moderate measure of parliamentary reform. But if, as is believed, Earl Grey was excluded from Mr Canning's Government by an express stipulation of the king, it follows *a fortiori* that the attorney-general of Queen Caroline could never be a minister of George IV. That sovereign had shown on several occasions that the attacks made on him by Brougham were never forgotten or forgiven; and Canning, whose own position at court was difficult enough, had certainly not the power to overcome the king's resentment. Brougham, however, promised and gave his shortlived administration an independent support—unlike Lord Grey, who fiercely and ungenerously attacked it.

University of London.

To this period of his life belong two occurrences which cannot be passed over in silence. In 1825 the first steps were taken, under the auspices of Brougham, for the establishment of a university in London, absolutely free from all religious or sectarian distinctions, a scheme which has grown and ripened in half a century into no unworthy rival of the other universities of northern and southern Britain. In 1827 Brougham contributed to found the "Society for the Diffusion of Useful Knowledge,"—an association which gave an immense impulse to sound popular literature. Its first publication was an essay on the "Pleasures and Advantages of Science," written by himself. One can hardly imagine at the present time with what avidity this paper was read, for it had no novelty of substance and no great merit of style. But a thirst for knowledge seemed suddenly to have seized the nation. It broke forth in mechanics' institutes and every form of instruction. To use his own language on a celebrated occasion—"the schoolmaster was abroad;" and the excitement he had contrived to kindle on these subjects tended to hasten a great crisis in our political life. In the following year (1828) he delivered his great speech on "Law Reform," which lasted six hours in the delivery in a thin and exhausted House,—a marvellous effort,—which embraced every part of the existing system of judicature, and concluded with one of his noblest perorations. "It was the boast of Augustus," he said, "and it formed part of the glory in which his early perfidies were lost, that he found Rome of brick and left it of marble,—a praise not unworthy of a great prince, and to which the present reign

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also has its claims. But how much nobler will be the sovereign's boast, when he shall have it to say that he found law dear and left it cheap; found it a sealed book, left it a living letter; found it the patrimony of the rich, left it the inheritance of the poor; found it the two-edged sword of craft and oppression, left it the staff of honesty and the shield of innocence!"

The death of Canning, the failure of Lord Goderich, and the accession of the duke of Wellington to power, again changed the aspect of affairs; but the resolution of ministers to carry Catholic Emancipation disarmed the Opposition, whilst it split the Tory party. Graver events were impending. The French Revolution of 1830, following close upon the death of George IV., awakened a passionate excitement throughout Europe, and especially in this country. The days of Tory government were numbered. The cry of "Reform" was raised; and the leader to "ride the whirlwind and direct the storm" was Henry Brougham. Then it was that the united county of York spontaneously returned him to the new House of Commons as their representative. It was the proudest moment of his life, for he was literally not only the representative of the county of York, but of the people of England. A stranger by birth to that great province, and without an acre of land in it, he, by his talents, eloquence, public services, and love of freedom alone, triumphed over the proud Yorkshire families, and took his seat in the House of Commons with a power no Englishman of this age has possessed. The Parliament met in November. Brougham's first act was to move for leave to bring in a bill to amend the representation of the people; but before the debate came on the Government was defeated on another question; the duke resigned, and Earl Grey was commanded by William IV. to form an administration.

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Amongst the difficulties the new premier and the Whig party had to encounter and to surmount, none was greater than that arising from the position, the attitude, and the talents of Mr Brougham. He was not the leader of any party; he had no personal following in the House of Commons; he was distrusted by the Whigs, who looked up to Lord Althorp as their chief; he was dreaded alike by friends and foes; but there stood, in solitary might, the formidable member for the county of York, armed with invincible eloquence, and backed by the suffrages of the people. He himself had repeatedly declared that nothing would induce him to exchange his position as an independent member of Parliament for any office, however great; and, no doubt, as an independent member of Parliament he exercised at that moment a power greater than any office could give. On the day following the resignation of the Government, he reluctantly consented, in low and angry tones, to postpone for one week his motion on parliamentary reform. The attorney-generalship was offered to him by Lord Grey; it was indignantly rejected. Brougham himself affirms that he desired to be master of the rolls, which would have secured him a large income for life, and left him free to sit in the House of Commons. But this was positively interdicted by the king, and objected to by Lord Althorp, who declared that he could not undertake to lead the House with so insubordinate a follower behind him. Meanwhile Brougham had discovered, at a meeting of several leading members of his party at Holland House, that he was not taken freely into their counsels; he came home exasperated and vowing vengeance against them. Lord Grey, personally, would have preferred to retain Lord Lyndhurst as his chancellor; but it was impossible to leave Brougham out, and he was only to be brought into the ministry by the offer of the great seal. When the question was considered at the first meeting of the inchoate ministry at Lansdowne House, Lord Holland said to his colleagues, "I suppose it must be so, but this is the last time we shall meet in peace within these walls." Brougham himself hesitated, or affected to hesitate. He was undoubtedly reluctant to quit the House of Commons and his seat for Yorkshire. His mother, with great wisdom, dissuaded him from accepting these treacherous gifts and honours. He alleged that, as the ministry might be of short duration, he was making a large sacrifice in giving up his professional income for a pension of £4000 a year and a peerage which he had no other means to support. But he yielded to the representations of Lord Grey and Lord Althorp, that without him as Chancellor the Government could not be formed. On the 22d November 1830 the great seal was delivered to him by the king, and he took his seat on the Woolsack that evening as speaker of the House of Lords, being still a commoner. On the following day, after he had sat to hear a Scotch appeal, the patent of his peerage as Baron Brougham and Vaux was brought down. The Lord chancellor then quitted the woolsack, robed, and was introduced as a baron by the Marquis Wellesley and Lord Durham.

Lord Chancellor.

The mind of man can conceive nothing more vivid and more various than the chancellorship of Lord Brougham. It lasted in all exactly four years—no more; but the times were burning with excitement, and the chancellor embodied and expressed the fervour of the times. To rival Lord Bacon in the philosophy of the closet and Lord Hardwicke in the courts of equity, to declaim like Chatham in the House of Lords, and jest like Sheridan at Lord Sefton's dinners, seemed alike easy tasks to Brougham. He never doubted of his own capacity to play every part in turn,—judge, statesman, orator, philosopher, buffoon; and he did play them all with as much success as an imitation can bear to a reality. Unhappily the verdict of time has proved that there was nothing of permanence, and little of originality, in the prodigious efforts of his genius. He affected at first to treat the business of the Court of Chancery as a light affair, though in truth he had to work hard to master the principles of equity, of which he had no experience. His manner in court was desultory and dictatorial. Sometimes he would crouch in his chair, muffled in his wig and robes, like a man asleep; at other times he would burst into restless activity, writing letters, working problems, interrupting counsel. Mortal offence he gave to Sugden, then the leader of the Equity bar, who detested his person and despised his law. But upon the whole Brougham was a just and able judge; and if few of his decisions are cited as landmarks of the law, still fewer of them have been overruled. His wonderful powers of despatch enabled him to work off the arrears of the court in ten months, a thing which had never before occurred in human memory, and in September 1831 he boasted that not a cause remained for hearing before the Lord Chancellor. Yet towards the close of his tenure of office in the spring of 1834, he complained to his colleagues of the tremendous drudgery he had undergone; he had sat up all the nights of winter, he said, to write seventy elaborate judgments, and he conceived that he was ill requited for the sacrifices he had made.

His duties as a judge, however, ranked second in his eyes to his duties as a politician and a legislator; and he took a most active and prominent part in the defence of all the great measures of Lord Grey's Government. We say in the defence of them, for he had less hand in the preparation of them than he wished it to be believed. His own statement that he had called his friends together and submitted to them a complete scheme of parliamentary reform is entirely unsupported, and, indeed, formally contradicted. The draft of the Reform Bill was prepared by a committee of four other members of the Cabinet, and accepted with some hesitation, [illegible]m. But once launched in the contest,

especially in the House of Peers, it owed a great deal to the vigour with which he defended it. The king, William IV., appears at first to have been amused and flattered by the attentions of his chancellor, who made infinite exertions to ingratiate himself with the court. But his manner, which was at first obsequious, became dictatorial; his restless eccentricity and his passion for interfering with every department of state, alarmed and irritated the king, and at last the former liking was turned into bitter aversion.

It would be superfluous in this place to follow the fortunes of the Reform Bill of 1832, and we shall confine ourselves to a brief notice of the part which Lord Brougham took in promoting it. The first grand crisis in the contest occurred in April 1831, when General Gascoyne's amendment was carried against the Government. A cabinet was held, and ministers agreed to advise the king to dissolve Parliament. The king not only assented, but expressed his readiness to go down to Westminster in a hackney coach if necessary. The elaborate narrative communicated by Lord Brougham to Mr Roebuck, and adopted by Mr Molesworth in his *History of the Reform Bill*,—by which it would appear that Lord Grey and the Lord Chancellor resorted to *management* and a species of mild compulsion in making this proposal to William IV., Lord Brougham having taken upon himself to order out the royal carriages and the guards,—is found on more exact inquiry to be unfounded. Unquestionably it was the duty of the prime minister to take the king's pleasure on such an occasion, though the chancellor, contrary to the usual practice, did accompany him, but the whole correspondence of the king on the subject of reform is addressed to Earl Grey alone. The second great crisis in the passage of the bill was in May 1832, when it became necessary to obtain from the king his consent to make peers in sufficient number to carry the bill, if the majority in the Upper House persevered in the attempt to defeat it. It has been stated, apparently on Lord Brougham's authority, that in the course of an audience granted to Lord Grey and himself, he succeeded in extorting from the king, in writing, the following paper:—

"The king grants permission to Earl Grey, and to his chancellor Lord Brougham, to create such a number of peers as will be sufficient to ensure the passing of the Reform Bill,—first calling up eldest sons.

(Signed) WILLIAM R.

"WINDSOR, *May* 17, 1832."

It is enough to say that this extraordinary document has never been seen by any one, and is not known to exist, therefore its exact tenor must be a mystery. The king was not at Windsor on the 17th May, but at St James's; and the Cabinet asked for an assurance of His Majesty's intentions on the following day (the 18th), which they would not have done if a written promise had been given the day before. This story, therefore, is incredible, and in Lord Brougham's autobiography nothing is said of this written paper. Lord Grey and Lord Brougham were both of them strongly averse to the creation of peers, which was fiercely urged on them by some of their colleagues, such as Lord Durham and Sir John Hobhouse. Lord Brougham has even intimated a doubt whether at the last extremity they should have used the power the king had at one time most reluctantly given them. But they both knew that their honour, and possibly their lives, were staked on carrying the bill; and, fortunately, they were relieved from the dire necessity of swamping the House of Lords by the influence of the king and the duke of Wellington over the Tory majority.

It is surprising that Lord Grey's administration, which had achieved so great a work in passing the Reform Bill, and was supported by an immense majority in the reformed Parliament, should so soon have come to an end. But Lord Grey was perpetually threatening to resign office; Lord Althorp longed for retirement; the question of the Irish Church led to the secession of four important members of the Cabinet; the queen was hostile; and the king was alarmed and dissatisfied with the Whig ministers. In July 1834 the crisis arrived, and having carried on the government for three years and 231 days, Lord Grey resigned. Lord Brougham had contrived to monopolize the authority and popularity of the Government, and no doubt his insatiable activity contributed to this result; and there were those who accused him of having intrigued to bring it about, with a view to superseding Lord Grey himself. But this imputation is unjust. Brougham, however, had caused Mr Littleton, the Irish secretary, to suggest to Lord Wellesley, the lord-lieutenant, that some of the clauses in the Irish Coercion Bill might be withdrawn on its renewal, with a view to conciliate O'Connell. Lord Althorp was of the same opinion; but Lord Grey refused to entertain the proposal, and on this rock the ship struck. Brougham declared with great vehemence that it was madness to resign, and that for his own part he had not tendered his resignation. Very much by his exertions the Cabinet was reconstructed under Lord Melbourne, and without Lord Grey; and he appeared to think that his own influence in it would be increased. He laboured at the time under extreme mental excitement,[1] and in this state he unfortunately proceeded to make a journey or progress to Scotland, where his behaviour was so extravagant that it gave the final stroke to the confidence of the king. At Lancaster he joined the bar-mess, and spent the night in an orgy. In a country house he lost the great seal, and found it again in a game of blindman's-buff. At Edinburgh, in spite of the coldness which had sprung up between himself and the Grey family, he was present at a banquet given to the late premier, and delivered a harangue on his own services and his public virtue. All this time he continued to correspond with the king in a strain which created the utmost irritation and amazement at Windsor. He seemed totally unconscious of the abyss which was opening at his feet. He was not the Bacon but the Wolsey of the 19th century.

Fall of Whig ministry.

The term opened in November with the usual formalities. But on the 16th of that month the king dismissed his ministers. The chancellor, who had dined at Holland House, called on Lord Melbourne in his way home, and learned the intelligence. Melbourne made him promise that he would keep it a secret till the morrow; but the moment he quitted the ex-premier, he sent a paragraph to the *Times* relating the occurrence, and adding that "the queen had done it all." That statement, which was totally unfounded, was the last act of his official life. The Peel ministry, prematurely and rashly summoned to power, was of no long duration, and Brougham naturally took an active part in overthrowing it. Lord Melbourne was called upon in April 1835 to reconstruct the Whig Government with his former colleagues. But, formidable as he might be as an opponent, the Whigs had learned by experience that Brougham was even more dangerous to them as an ally, and with one accord they resolved that he should not hold the great seal or any other office. The great seal was put in commission, to divert for a time his resentment, and leave him, if he chose, to entertain hopes of recovering it. These hopes, however, were soon dissipated; and although the late chancellor assumed an independent position in the House of Lords, and even affected to protect the Government, his resentment against his "noble friends"

Later parliamentary labours.

[1] Mr Greville records in his Journal a conversation with Lord Melbourne of the 23d September in this year, from which it is clear that Melbourne was perfectly aware of the state the chancellor was in, and that he hardly thought him of sound mind. He added, "The king can't bear these exhibitions in Scotland."

soon broke out with uncontrolled vehemence. Throughout the session of 1835 his activity was undiminished. Bills for every imaginable purpose were thrown by him on the table of the House, and it stands recorded in *Hansard* that he made no less than 221 reported speeches in Parliament in that year. But in the course of the vacation a heavier blow was struck. Lord Cottenham was made Lord Chancellor. The breach had manifestly become irreparable. Even Lord Brougham's buoyant and daring spirit sunk for a time under the shock. A dreadful period of depression succeeded to the wild frenzy of the preceding years, and during the year 1836 the voice of Lord Brougham was unheard. He passed the spring and summer in Westmoreland, and avoided all political conversation and correspondence. Fifty-six years of his life were spent, and not much more than twenty of them had been spent in Parliament, where he had earned the most prodigious reputation and influence of modern times. "What is the House of Lords without Brougham?"—we have heard Lord Lyndhurst say—"Brougham *is* the House of Lords." For more than thirty years after his fall he continued to take an active part in its judicial business and in its debates. There was still a power in the tone of that voice, raised as it always was in the cause of peace, humanity, and freedom; but it would have been better for his fame if he had died in the midst of his glory. His reappearance in Parliament on the accession of Queen Victoria was marked by sneers at the Court, and violent attacks on the Whigs for their loyal and enthusiastic attachment to their young sovereign; and upon the outbreak of the insurrection in Canada, and the miscarriage of Lord Durham's mission, he overwhelmed his former colleagues, and especially Lord Glenelg, with a torrent of invective and sarcasm, equal in point of oratory to the greatest of his earlier speeches. But why pursue the painful narrative of these writhings of a wounded spirit and a broken ambition? Without avowedly relinquishing his political principles, Brougham had estranged himself from the whole party by which those principles were defended. Flattered, and not unwilling to be flattered, by the Tories, he fought side by side with Lyndhurst, and paid the most fulsome court to the duke of Wellington and a long train of women of quality and men of fashion.

Amongst the humorous expedients resorted to in order to keep his name before the public, a false report of his death was sent up from Westmoreland in 1839, which obtained credence from the persons to whom it was addressed. The newspapers published articles on the melancholy event, and in the *Morning Chronicle* Mr Sheil exclaimed—

> "The extravagant and erring spirit hies
> To his confine,"

whilst he paid a just tribute to the splendid talents and services of the deceased.

Judicial services

It is more agreeable to dwell on the judicial services he continued assiduously to render in the Privy Council and the House of Lords. The Privy Council, especially when hearing appeals from the Colonies, India, and the courts maritime and ecclesiastical, was his favourite tribunal. He had practised a good deal before it (or, as he always called it, "the Cock-pit," so named because the cock-pit of Henry VIII. was the site of the present council chamber) when a young man, before he was called to the English bar; its vast range of jurisdiction, varied by questions of foreign and international law, suited his discursive genius. He had remodelled the judicial committee in 1833, and it still remains one of the most useful of his creations; and he at one time aimed at making himself the president of this committee. To this board Lord Brougham devoted for about sixteen years a very considerable amount of time and labour, and many of his most able and elaborate judgments are recorded in the Privy Council reports which have contributed to build up and perfect the modern jurisprudence of India, and to maintain principles of toleration in the Church of England.[1] He ceased to attend the Privy Council in 1850. But he continued to the close of his life to hear appeals in the House of Lords, where his early knowledge of Scotch law was of peculiar value

Second patent of peerage.

In the year 1860, a second patent was conferred upon him by Her Majesty Queen Victoria, with a reversion of his peerage to his youngest brother William Brougham. The preamble of this patent stated that this unusual mark of honour was conferred upon him by the Crown as an acknowledgment of the great services he had rendered, more especially in promoting the abolition of slavery and the emancipation of the negro race. The peerage is thus perpetuated in a junior branch of his family. Lord Brougham's marriage with Mrs Spalding had given him no male heirs, and his only daughter died in early life unmarried.

Retirement at Cannes.

Upon the portal of one of those delightful villas which nestle amongst the olive trees and the carob trees at Cannes, along the shores of the Mediterranean, are inscribed the lines—

> "Inveni portum: spes et fortuna valete.
> Sat me lusistis; ludete nunc alios."

Such was the haven, such the abode, in which Lord Brougham found repose from the triumphs and the disappointments of his agitated existence. The pure and genial air of the South calmed his nerves and perhaps prolonged his life. There he returned with undiminished pleasure to the head-springs of science, philosophy, and literature. His spirits were more equable; his mind more calm; his society charming. There, then, he spent a considerable part of the later years of his life; and there, when the hour of departure came, his remains mingled with the dust. An accident had attracted his attention to the spot about the year 1838. He bought a tract of land; he built on it; and the Villa Louise Eleonore recalled by its name the adored memory of his lost and only child. Cannes, when he first visited it, was little more than a fishing village on a picturesque coast. His choice and his example made it the sanatorium of Europe.

Last years.

The fame of Lord Brougham had long extended far beyond the frontiers of his native land. The generous and lofty sentiments which he clothed in forcible language touched the heart of mankind. But there was something peculiarly congenial to his own mercurial temperament in the life and genius of France. In 1833 the Academy of Moral and Political Science had conferred upon him the high rank of an associate of the Institute. The Academy of Science did not disdain to listen to his demonstrations. The French, with their lively sympathy for brilliant intellectual power, forgave him all his eccentricities. He has been known to *tutoyer* M. Guizot. He once asked the French Government to give him an island with a state prison on it. He would drop in to tea at the Tuileries in his chequered trousers, and sometimes bring a friend with him, utterly regardless of social usages and etiquette. His French, though fluent enough, was as barbarous and dissonant a brogue as ever tortured the ears of a Parisian. Nobody knew what he would do next. After the revolution of 1848 he asked M. Cremieux (in utter forgetfulness of French law) to have him made a French citizen. But friendship in France is warm and tenacious. Lord Brougham had contributed as much as any man to efface old hatreds and to establish a lasting alliance between France and Great Britain. He judged even her faults in a kindly and indulgent spirit; and of all the tributes to his memory which have issued from the press, none is at once more truthful and more

[1] Thus the judgment on the case of Escott *v.* Martin, which established the validity of baptism administered by a Wesleyan minister or a layman, was prepared and delivered by Lord Brougham.

tender than the discourse pronounced by M. Mignet in the Institute of France in honour of their great associate. Upon that southern coast the last days of this veteran combatant in the fields of law and politics were spent. There at Cannes, upon the 7th May 1868, in the ninetieth year of his age, he expired; and if Westminster proffered no sepulture to the greatest orator of our times, he rests, at least, in the spot which had his latest affections.

To what precedes we have little to add, for who can attempt to portray so multifarious, inconsistent, and variable a being? The irritability of his temper and the egotism of his character made him not only formidable as an antagonist but dangerous as a friend. Yet at bottom he had genuine warmth of heart and good nature. He was a devoted son, an affectionate parent and brother; covetous to a degree of power and patronage, but prodigal in the use of it; disdaining money, yet happy to bestow it on others; fond of courting the great, yet not insensible to the sufferings and the sympathy of the humble and the poor. With unbounded self-confidence, he wanted self-control, and at times under the influence of grief, of resentment, of ambition, of disappointment, or of success, he was scarcely accountable for his actions, still less for his language. His imagination conjured up occurrences which had never taken place; and he changed as rapidly as a chameleon, unconscious of the transformation. Hence it came to pass that whilst men marvelled at his astonishing gifts, they ceased to trust his character; and the splendid promise of the morning of his life was overcast before its close.

The activity of Lord Brougham's pen was only second to the volubility of his tongue. He carried on a vast and incessant correspondence of incredible extent. For thirty years he contributed largely to the *Edinburgh Review*, and he continued to write in that journal even after he held the great seal. The best of his writings, entitled "Sketches of the Statesmen of the time of George III.," first appeared in the *Review*. These were followed by the "Lives of Men of Letters and Science" of the same period. Later in life he edited Paley's *Natural Theology*; and he published a work on political philosophy, besides innumerable pamphlets and letters to public men on the events of the day. He published an incorrect translation of Demosthenes's *Oration for the Crown*. A novel entitled *Albert Lunel* was attributed to him. A fragment of the *History of England under the House of Lancaster* employed his retirement, but we think it was published without his name, and certainly without success. In 1838 Messrs Black of Edinburgh published an edition of his speeches in four volumes, 8vo, elaborately corrected by himself. The last of his works was his posthumous *Autobiography*. Yet ambitious as he was of literary fame, and jealous of the success of other authors, he failed to obtain any lasting place in English literature. His style was slouching, involved, and incorrect. Like his handwriting, which was precipitate and almost illegible, except to the initiated, his composition bore marks of haste and carelessness, and nowhere shows any genuine originality of thought. The collected edition of his works and speeches published by Griffin in 1857, and reissued by Black, of Edinburgh, 1872, is the best; and it was carefully revised by himself, with introductions to the different pieces. His autobiography is of some value from the original letters with which it is interspersed. But Lord Brougham's memory was so much impaired when he began to write his recollections, that no reliance can be placed on his statements, and the work abounds in manifest errors. (H. R.)

BROUGHTON, Hugh, a learned scholar and divine, was born at Oldbury in Shropshire in 1549. After receiving the rudiments of his education at a provincial school, he went to Cambridge, where in due time he was chosen a fellow of Christ's College, and took orders in the church. During his career at the university he laid the foundation of the Hebrew scholarship for which he was afterwards so distinguished. From Cambridge he went to London, where his eloquence gained him many and powerful friends. In 1588 he published his first work, "a little book of great pains," entitled the *Consent of Scriptures*. This work was strongly opposed at both the great universities, and the author was obliged to defend it, which he did in a series of lectures. In 1589 he went to Germany, where he frequently engaged in discussions both with Romanists and with the learned Jews whom he met at Frankfort and elsewhere. In 1591 he returned to England, and published an *Explication of the article of Christ's descent into Hell*, which, like his former treatise, elicited a violent opposition. In 1592 he once more went abroad and cultivated the acquaintance of the principal scholars of the different countries through which he passed. Such was the esteem in which he was held, even by his opponents, that he was offered a cardinal's hat if he would renounce the Protestant faith, which, however, he declined to do. On the accession of James he returned to England; but not being engaged to co-operate in the new translation of the Bible then begun, he retired to Middleburg in Holland, where he preached to the English congregation. In 1611 he returned to England, where he died the following year. Some of his works were collected and published in a large folio volume in 1662, with a sketch of his life by Dr Lightfoot, but many of his theological MSS. remain still unedited in the British Museum.

BROUGHTON, Thomas, a learned divine, and one of the original writers in the *Biographia Britannica*, was born at London, July 5, 1704. At an early age he was sent to Eton, where he soon distinguished himself by his acuteness and studious disposition. Being superannuated on this foundation, he removed about 1722 to the university of Cambridge; and, for the sake of a scholarship, entered himself of Caius College. Here two of the principal objects of his attention were the acquisition of the modern languages, and the study of mathematics, under the famous Professor Sanderson. In May 1727, Broughton, after graduating as B.A., was admitted to deacon's orders, and in the succeeding year was ordained priest, and took the degree of M.A. He then removed from the university to the curacy of Offley in Hertfordshire. In 1739 he was instituted to the rectory of Stepington, or Stibington, in the county of Huntingdon. He was soon after chosen reader to the Temple, by which means he became known to Bishop Sherlock, then Master, who conceived so high an opinion of Broughton's merit, that in 1744 he presented him to the valuable vicarage of Bedminster near Bristol, with the chapels of St Mary Redcliff, St Thomas, and Abbot's Leigh annexed. He was afterwards collated by the same patron to the prebend of Bedminster and Redcliff, in the cathedral of Salisbury. Upon receiving this preferment he removed from London to Bristol, where he married the daughter of Thomas Harris, clerk of that city, by whom he had seven children. He died December 21, 1774.

BROUGHTON, John Cam Hobhouse, Lord, an English statesman, was the eldest son of Sir Benjamin Hobhouse, first baronet, and was born at Redlands, Bristol, June 27, 1786. He was educated at Westminster School and Trinity College, Cambridge, where he took his degree of B.A. in 1808. During his residence at Cambridge he became the intimate friend of Lord Byron; and in the summer of 1809 the two friends set out together on a tour in the South of Europe. They visited Spain (then the theatre of the great war with Napoleon), Portugal, Greece, Albania, and Turkey. The winter was spent at

Athens, and in 1810 Hobhouse returned home. In the campaigns of 1813 and 1814 he accompanied the allied armies, and was present at the great battle of Dresden. In the winter of 1816–17 he rejoined Byron in Italy, and they visited Venice and Rome together. Hobhouse had been trained in the Liberal school of politics, and had written pamphlets and review articles in defence of liberal doctrines. He had by this time become what was then contemptuously called a "downright radical." In 1816 he published anonymously a work in two volumes entitled, *The Substance of some Letters written by an English Gentleman Resident at Paris during the last Reign of the Emperor Napoleon.* His aim in it was to correct certain misrepresentations which were current of the events of the Hundred Days. The tone of the book gave great offence to the English Government; and being translated into French was equally offensive to the Government of the Restoration. The French translator and printer were both prosecuted in 1819 for "atrocious libel" on the Government; and were sentenced to fine and imprisonment, the former for twelve months, the latter for six. On 13th December of the same year the speaker's warrant was issued for the arrest of Hobhouse, and he was committed to Newgate. He made an unsuccessful application to Chief-Justice Abbott (Lord Tenterden) for discharge by *habeas corpus*, and he was not liberated till about the end of February. The treatment which he had suffered gave him the prestige of a martyr to the dominant Toryism, and in the eyes of the multitude this was his glory. At the close of 1818 he had contested the borough of Westminster, Sir Francis Burdett desiring him as a colleague, and giving £1000 towards the necessary expenses of his candidature. But he was beaten by his rival, George Lamb, the brother of Lord Melbourne. He now came forward again, and was returned by a large majority (1820). In the first session of parliament he produced a powerful impression, first by his severe speech on the suppression of a Liberal meeting at Oldham, and soon after by the vigorous support he gave to the bill for disfranchising the borough of Grampound. During the next twelve years he was the ardent and courageous advocate of all Liberal measures,—among them, of the repeal of the Test and Corporation Acts, and of Catholic Emancipation. In August 1831 he succeeded to the baronetcy, and six months later was called to office as Secretary for War under the ministry of Earl Grey. In April 1833 he was named Chief-Secretary for Ireland, but lost his seat at the new election. In the following year he was returned M.P. for Nottingham, and received the appointment of Chief-Commissioner of Woods and Forests under Lord Melbourne. Retiring with the Liberal party in the autumn, he resumed office in April 1835 as President of the Board of Control, a post for which he was well qualified, and which he held till September 1841. He was recalled to the same office under the Russell Administration in 1846, and held it till 1852. Meanwhile he had lost his seat for Nottingham and had been returned for Harwich. In 1851 he was raised to the peerage, and from that time showed himself disposed to "rest and be thankful." He gradually ceased to take part in public affairs, and returned to the studies and literary enjoyments of his youth. Lord Broughton published a volume of *Imitations and Translations from the Classics*; an account of his *Journey through Albania and other Provinces of Turkey with Lord Byron*; and *Historical Illustrations of the Fourth Canto of "Childe Harold."* He was also a contributor to periodical literature. In 1828 he married Lady Julia Hay, youngest daughter of the Marquis of Tweeddale, by whom he had three daughters, but no son. His wife died many years before him. Lord Broughton died in London, June 3, 1869. As he left no male issue his peerage became extinct.

BROUKHUSIUS, or BROEKHUIZEN, JAN, a distinguished scholar, born in 1649 at Amsterdam, where his father was a clerk in the Admiralty. His father dying when he was very young, he was taken from literary pursuits, in which he had made great progress, and placed with an apothecary at Amsterdam, with whom he lived several years. Not liking this employment, he entered the army, and in 1674 was sent with his regiment to America, in the fleet under Admiral de Ruyter, but returned to Holland the same year. In 1678 he was sent to the garrison at Utrecht, where he contracted a friendship with the celebrated Grævius; and here he had the misfortune to be so deeply implicated in a duel, that, according to the laws of Holland, his life was forfeited. Grævius, however, wrote immediately to Nicholas Heinsius, who obtained his pardon. Not long afterwards he became a captain of one of the companies then at Amsterdam; and was thus enabled to pursue his studies at his leisure. His company being disbanded in 1697, he received a pension, upon which he retired to a country-house near Amsterdam. He died in 1707, aged fifty-eight.

As a classical scholar, he is distinguished by his editions of Propertius and Tibullus, the former published in 1702, the latter in 1708. His *Carmina* were published at Utrecht, 1684, in 12mo; and in a more handsome form by Van Hoogstraatten, Amsterdam, 1711, 4to. His Dutch poems were also published at Amsterdam, 1712, 8vo, by the same house, with a life prefixed.

BROUSSA, BRUSSA, or BRUSA, in Turkish *Bursa*, a city of Asiatic Turkey, in the province of Anatolia, and capital of the sanjak of Khodavendkiar, is situated in a fertile valley, at the northern foot of Mount Olympus or Keshish Dagh, 57 miles S.S.E. of Constantinople. Its streets are narrow and dark, and its houses are for the most part built of wood; but its numerous minarets give it a magnificent appearance from a distance, and the rich variety of colouring that everywhere meets the eye has a very striking effect. It is abundantly supplied with water, which flows down the middle of many of the streets, and rises every here and there in beautiful fountains. On the top of a rock in the heart of the town stands the ancient citadel, the walls of which date from the 13th century, and are of Greek construction; and on the west side is the Byzantine church of Elijah, which is now known as the Daud Monasteri mosque, and contains the tomb of Orkhan. The most important of the other mosques, the number of which is said to be upwards of 600, are *Oglú Jami*, or the mosque of the three sultans; the *Yeshil Jami*, or the green mosque; and *Ghan Unkiar Jami*, or the mosque of the conqueror. There are also in the town three Greek churches, one Armenian, and several synagogues. Many of its colleges, bazaars, and caravanserais are buildings of considerable importance, and bear comparison with those of Constantinople. Broussa is the seat of a provincial governor, of a mollah or judge, who ranks as third in the kingdom, and of a mufti or spiritual chief. The Greeks and Armenians have each an archbishop in the town. As a commercial city Broussa ranks with the most flourishing in the empire. The town of Gemlik at the head of Mudani Bay, from which it is about 20 miles distant, serves as its port. It manufactures carpets, tapestry, and various kinds of silk goods, the material for the latter being obtained from the mulberry-plantations of the neighbourhood. In 1862 there were no fewer than sixty silk factories belonging to Italians, Frenchmen, and Germans. About a mile and a half from the town are the famous baths of Broussa, which are fed by several mineral springs varying in temperature up to 184°, and from a hill in the vicinity is obtained a good supply of meerschaum clay. The population of Broussa is variously estimated,—by Mostrás (*Dict. Géog. de l'Empire Ottoman*, 1873) in 1863 at 70,000, by Dr C. Sandreczki in 1844 at 60,000, and by Consul Sax at 40,000.

Broussa, the *Prusa* of the classical writers, founded, it is said, at the suggestion of Hannibal, was for a long time the seat of the Bithynian kings. It continued to flourish under the Roman and Byzantine emperors till the 10th century, when it was captured and destroyed by Seif-ed-daulet of Aleppo. Restored by the Byzantines, it was again taken in 1327 by the Ottomans after a siege of ten years, and continued to be their capital till Amurath I. removed to Adrianople. In 1402 it was pillaged by the Tatars; in 1413 it resisted an attack of the Karamanians; in 1512 it fell into the power of Ala Eddin; and in 1607 it was burnt by the rebellious Kalenderogli. In 1833 it was seized by Ibrahim Pasha, and from 1852–55 afforded an asylum to Abd-el-Kader. In modern times it has suffered several times from earthquake and conflagration, especially in 1855.

BROUSSAIS, FRANÇOIS JOSEPH VICTOR, a celebrated French physician, was born at St Malo in 1772. From his father, who was also a physician, he received his first instructions in medicine, and he studied for some years at the college of Dinan. At the age of seventeen he entered one of the newly-formed republican regiments, but ill health compelled him to withdraw after about two years. He resumed his medical studies, and after passing some time in the hospitals of St Malo and Bryt, obtained an appointment as surgeon in the navy. In 1799 he proceeded to Paris, where in 1803 he graduated as M.D. In 1805 he again joined the army in a professional capacity, and served in Germany, Holland, Italy, and Spain. In 1814 he returned to Paris, and was appointed assistant-professor to the Military Hospital of the Val-de-Grace, where he first promulgated his peculiar doctrines. His theory, which strongly resembles that of John Brown, points to excitation or irritation as the fundamental fact in life. He found the principal cause of disease in over-irritation, which, primarily local, extends itself through sympathy to the other organs of the body, as in fever. His lectures were attended by great numbers of students, who received with the utmost enthusiasm the new theories which he propounded. In 1816 he published his *Examen de la doctrine médicale généralement adoptée*, which drew down upon its author the hatred of the whole medical faculty of Paris. By degrees his doctrines triumphed; and were adopted in the writings and practice of the best physicians, and even in the medical school itself, long before their propounder held office in that institution. In 1831 he was appointed professor of general pathology in the academy of medicine, and taught with great applause till his death in 1838. The recent development of physiological science has shown that his theories are but partially true, and are of little value as a general explanation of disease. Of his works, which are very numerous, the most important are the *Examen* and *De l'Irritation et de la Folie.*

BROUSSONET, PIERRE MARIE AUGUSTE, a distinguished French naturalist, was the son of a schoolmaster, and was born at Montpellier in 1761. He was educated for the medical profession, and at the age of eighteen was appointed to fill a professor's chair. Botany seems to have been the science to which he was at first chiefly devoted; and he laboured with much zeal to establish the system of Linnæus in France. With this view, as well as for his own improvement, he went to Paris, and visited the various museums and collections. He next came to England, and was admitted in 1782 an honorary member of the Royal Society. He published at London the first part of his work on fishes, *Ichthyologiæ Decas I.* On his return to Paris he was appointed perpetual secretary to the Society of Agriculture, an office which the intendant Berthier de Sauvigny resigned in his favour. In 1789 he was nominated a member of the Electoral College of Paris, and for some time had the charge of superintending the supply of provisions for the capital. Under the Convention he had to leave Paris, and after some dangers he made his way to Madrid. The enmity of the French emigrants, however, drove him from Spain, and afterwards from Lisbon, where he had sought an asylum. At last he went out as physician to an embassy which the United States sent to the emperor of Marocco; and on this occasion his friend Sir Joseph Banks, informed of his distresses, remitted him £1000. After residing for some time at Marocco, he obtained from the French Directory permission to return to France, and was appointed by them consul at Teneriffe, where he resided for two years. On his return in 1797 he was chosen member of the Institute, and was reinstated in his botanical professorship at Montpellier, with the direction of the botanical garden. He was afterwards elected a member of the legislative body, but died of apoplexy on the 27th July 1807. France is indebted to him for the introduction of the Merino sheep and the Angora goat. None of his works are now of importance.

BROUWER, ADRIAN, a Dutch painter, was born at Haarlem in 1608, of very humble parents, who bound him apprentice to the painter Frank Hals. Brouwer had an admirable eye for colour, and much spirit in design; and these gifts his master appears to have turned to his own profit, while his pupil was half starved. As the result of this ungenerous treatment, Brouwer was frequently brought into low company and dissipated scenes, which he delineated with great spirit and vivid colouring in his pictures. The unfortunate artist died in a hospital at Antwerp in 1640, at the early age of thirty-two, consequently his works are few and rarely met with. The largest collection of his masterpieces is in the picture gallery at Munich.

BROWN, CHARLES BROCKDEN, the first American novelist who acquired an European reputation, and the first American who made literature a profession, was born of Quaker parents in Philadelphia, January 17, 1771. A youth of delicate constitution and retiring habits, he early devoted himself to study; his principal amusement was the invention of ideal architectural designs, devised on the most extensive and elaborate scale. This characteristic talent for construction subsequently assumed the shape of utopian projects for perfect commonwealths, and at a later period of a series of novels distinguished by the ingenuity and consistent evolution of the plot. The transition between these intellectual phases is marked by a juvenile romance entitled *Carsol*, not published until after the author's death, which professes to depict an imaginary community, and shows how thoroughly the young American was inspired by Godwin and Mary Wollstonecraft, whose principal writings had recently made their appearance. From the latter he derived the idea of his next work, *Alcuin*, an enthusiastic but inexperienced essay on the question of woman's rights and liberties. From Godwin he learned his terse style, condensed to a fault, but too laconic for elcquence or modulation, and the art of developing a plot from a single psychological problem or mysterious circumstance. The novels which he now rapidly produced offer the strongest affinity to *Caleb Williams*, and if inferior to that remarkable work in the subtlety of mental analysis, greatly surpass it in affluence of invention and intensity of poetical feeling. All are wild and weird in conception, with incidents bordering on the preternatural, yet the limit of possibility is never transgressed. In *Wieland*, the first and most striking, a seemingly inexplicable mystery is resolved into a case of ventriloquism. *Arthur Mervyn* is remarkable for the description of the epidemic of yellow fever in New York in 1798, which had proved fatal to the author's most intimate friend. *Edgar Huntly*, a romance rich in local colouring, is remarkable for the effective use made of somnambulism, and anticipates Cooper's introduction of the Red Indian into fiction. *Ormond* is less powerful, but contains one character, Constantia Dudley, which excited the enthusiastic admiration of Shelley, who was also deeply entranced by Brown's other romances. "Nothing," asserts Mrs Peacock, "so blended

itself with the structure of his interior mind as the creations of Brown." The two had, indeed, nearly every leading trait in common, although Brown's weak health and narrow circumstances restrained him from carrying his enthusiastic aspirations into practice. Two subsequent novels, designed as representations of ordinary life, proved failures, and Brown betook himself to less ambitious literary pursuits, compiling a general system of geography, editing a periodical, and an annual register, and writing political pamphlets which attracted considerable attention at the time. He died of consumption, February 22, 1810. He is depicted by his biographer as the purest and most amiable of men, and in spite of a certain formality due, perhaps, to his Quaker education, the statement is borne out by his correspondence. As a novelist he ranks very high; he is the precursor of Hawthorne, and hitherto his only American rival. Greatly inferior to Hawthorne in truth of natural description and insight into human character, he surpasses him in narrative and constructive ability. *Wieland* and *Edgar Huntly* especially are thrilling and exciting in the highest degree, while preserved by the constant presence of a psychological problem from degenerating into mere sensationalism. Most of Brown's novels have been reprinted in England, but none recently. His life by his friend Dunlop (Philadelphia, 1815) is a grievous piece of bookmaking, but is interesting from the subject. An edition of his works in 6 vols. was published at Philadelphia in 1857. (R. G.)

BROWN, JOHN, D.D., an English divine and author, was born at Rothbury, Northumberland, in November 1715. He was the son of John Brown, a descendant of the Browns of Coalstown near Haddington, who at the time of his son's birth was curate of Rothbury. He was educated at St John's, Cambridge; and after graduating as B.A. with great distinction, he returned to his father's house at Wigton, received deacon's and priest's orders from Sir George Fleming, bishop of Carlisle, and in 1739 went to Cambridge to take his M.A. degree. In 1745 he distinguished himself as a volunteer, and was soon afterwards appointed one of his chaplains by Dr Osbaldeston, on his admission to the bishopric of Carlisle. It was probably during his residence at Carlisle that Brown wrote his poem entitled *Honour*, inscribed to Lord Lonsdale. His next poetical production was his *Essay on Satire*, addressed to Dr Warburton, to whom it was so acceptable, that he took Brown into his friendship. He also introduced him to Ralph Allen, of Prior Park, near Bath, to whom in 1751 Brown dedicated his *Essay on the Characteristics of Lord Shaftesbury*. In 1754 he was promoted by the earl of Hardwicke to the living of Great Horkesley in Essex, and in the following year he took the degree of doctor of divinity at Cambridge. In this year also he published his tragedy of *Barbarossa*, which, under the management of Garrick, was acted with considerable applause, though it was sharply censured when published. This tragedy was followed by a second, entitled *Athelstane*, which was represented at Drury Lane theatre. This was also well received by the public, but did not become so popular as *Barbarossa*. Among the most remarkable of his other productions are the *Estimate of the Manners and Principles of the Times*, a bitter satire; the *Additional Dialogue of the Dead*, which was a vindication of Chatham's policy; and the *Dissertation on the Rise, Union, and Power, &c., of Poetry and Music*. Dr Brown, who had an hereditary tendency to insanity, and from early life had been subject at times to fits of excessive melancholy, committed suicide on the 23rd of September 1766

BROWN, JOHN, author of the *Self-Interpreting Bible*, was born at Carpow, in Perthshire, in 1722. He was almost entirely self-educated, having acquired a knowledge of Latin, Greek, and Hebrew while employed as a shepherd. He was, for a great part of his life, minister of the Burgher branch of the Secession Church in Haddington, and also discharged the duties of professor of divinity. Though he had not enjoyed the advantages of a regular education, he mastered the classical tongues, as well as several modern and Oriental languages, and gained a just reputation for learning and piety. He died in 1787. The best of his works, which are very numerous, are his *Self-Interpreting Bible* and *Dictionary of the Bible*, works that were long very popular in Scotland. He also wrote a valuable *Body of Divinity*.

BROWN, JOHN, the founder of the Brunonian theory of physic, was born in 1735 at *Lintlaws* or at Preston, Berwickshire. He was originally destined for the employment of a weaver, but the boy's talents attracted the attention of his schoolmaster, through whose endeavours his parents were encouraged to allow him to begin study for the church. At the age of twenty he came to Edinburgh and entered the classes at the university, supporting himself by private tuition. In 1759 he seems to have discontinued his theological studies, and to have begun the study of medicine. He soon attracted the notice of Dr Cullen, who engaged him as private tutor to his family, and treated him in some respects as an assistant professor. Brown, however, thought that Cullen did not advance his candidature for a vacant chair, and the friendship between the two was soon completely broken. In 1780 appeared the *Elementa Medicinæ*, expounding the new, or as it was then called the Brunonian, theory of medicine. The fundamental idea of this theory was the division of diseases into two classes, sthenic and asthenic, the one caused by excess, the other by deficiency of excitement, and the consequent method of treatment by debilitating or stimulating medicines. That Brown's ideas should have excited the discussion they did seems now incredible. Shortly after the publication he obtained the degree of M.D. at St Andrews, and in 1786 he set out for London in the hope of bettering his fortunes. He died of apoplexy in October 1788. A *Life* of Brown by Beddoes was published in 1801. An edition of his works, with notice of his life by his son, W. C. Brown, appeared in 1804.

BROWN, JOHN, D.D., an eminent Scottish divine, son of the Rev. John Brown of Whitburn, and grandson of the Rev. John Brown of Haddington, was born at Whitburn, Linlithgowshire, on the 12th July 1784. He studied at Glasgow university, and afterwards at the divinity hall of the "Burgher" branch of the "Secession" Church at Selkirk, under the celebrated Lawson. In 1806 he was ordained minister of the Burgher congregation at Biggar, Lanarkshire, where he continued to labour for sixteen years with growing popularity. Transferred in 1822 to the charge of Rose Street church, Edinburgh, he at once took a high rank as a preacher. Deficient in imagination and in spontaneity of utterance, he had nearly all the other qualities of a pulpit orator,—a powerful and flexible voice, a presence at once winning and commanding, clear and persuasive reasoning, and a habitual earnestness, rising not unfrequently into fervour. In 1829 he succeeded Dr Hall in the pastoral charge of Broughton Place church, Edinburgh, where his congregation speedily became one of the largest in the city. In 1835 he was appointed one of the professors in the theological hall of the Secession Church, and, great as was his ability as a preacher and pastor, it was probably in this sphere that he rendered his most valuable service to his own denomination and the church at large. He had been the first in Scotland to introduce in his pulpit ministrations what is known as the exegetical method of exposition of Scripture, and he fully availed himself of his position as a professor to illustrate the

method and extend its use. To him probably more than to any other man is due the abandonment of the radically vicious principle of interpretation according to the "analogy of faith," which practically subordinated the Bible to the Creed. To his favourite task of exegesis, which he himself described as the main object of his public life, Dr Brown brought a rare critical sagacity, exact and extensive scholarship, unswerving honesty, and a clear, logical style. His expository works, noted below, have accordingly a permanent value. Dr Brown was naturally of a retiring disposition, but the strength of his convictions forced him to take a prominent part in the chief religious and political discussions of his time. He had a considerable share in the Apocrypha controversy, and he was throughout life a vigorous and consistent upholder of anti-state-church or "voluntary" views. His two sermons on *The Law of Christ respecting civil obedience, especially in the payment of tribute*, called forth by a local grievance from which he had personally suffered, were afterwards published with extensive additions and notes, and are still regarded as an admirable statement and defence of the voluntary principle. In a discussion which agitated his denomination for several years in regard to the nature and extent of the atonement, Dr Brown took a part which led to a formal charge of heresy being preferred against him. In 1845, after the to him peculiarly painful ordeal of a somewhat protracted trial, he was acquitted by the Synod. From that time he enjoyed the thorough confidence of his denomination (after 1847 "the United Presbyterian Church"), of which in his later years he was generally regarded as the leading representative. Dr Brown died on the 13th October 1858.

Dr Brown's chief works were—*Expository Discourses on First Peter* (1848); *Exposition of the Discourses and Sayings of our Lord* (1850); *Exposition of our Lord's Intercessory Prayer* (1850); *The Resurrection of Life* (1851); *Exposition of the Epistle to the Galatians* (1853); and *Analytical Exposition of the Epistle to the Romans* (1857). See *Memoir of John Brown, D.D.*, by John Cairns (1860).

BROWN, JOHN, an American abolitionist, celebrated as the originator of the Harper's Ferry insurrection, was born in Torrington, Connecticut, on the 9th May 1800. Originally intended for the church, he was compelled to give up study for this purpose on account of inflammation in the eyes. He then took up the business of a tanner, which he carried on for twenty years. Not being very successful in trade, he started business as a wool-dealer in Ohio in 1840. Failing also in this he removed to Essex county, New York, in 1849, and began to reclaim a large tract of land which had been granted to him. After two years he returned to Ohio and resumed his business as a wool-dealer. In 1855, with his four sons, he migrated to Kansas, and at once took a prominent position as an anti-slavery man. He became renowned in the fierce border warfare which was carried on for some years in Kansas and Missouri, and gained particular celebrity by his victory at Ossowattomie. About this time he seems to have formed the idea of effecting slave liberation by arming the slaves and inciting them to rise in revolt against their oppressors. As the first step in this scheme, he designed to seize the arsenal of Harper's Ferry, where an immense stock of arms was kept. On the night of the 16th October 1859, he, with a handful of well-armed and resolute companions, overpowered the small guard and gained possession of the arsenal. During the next morning he made prisoners of some of the chief men of the town, but there was no rising of slaves as had been expected. The townsmen, too, recovered from their astonishment at the audacity of the act, and a bold attack was made on the arsenal. Fresh assailants poured in from the country round, and on the morning of the 18th the arsenal was recaptured, and Brown, severely wounded, was taken prisoner. On the 27th October he was tried at Charlestown for treason and murder, and was found guilty. The sentence passed upon him, death by hanging, was carried into execution on the 2d December. His fate made an extraordinary impression on the excited feelings of the Americans, and his name has become a household word among the Abolitionists.

BROWN, ROBERT, the founder of the Brownists, a numerous sect of dissenters in the reign of Queen Elizabeth, was born in 1550. He was the son of Anthony Brown of Tolthorp in Rutlandshire, whose father obtained, by a charter of Henry VIII., the singular privilege of wearing his cap in the king's presence. Robert was educated at Cambridge, and was afterwards a schoolmaster in Southwark. About the year 1580 he began to promulgate his principles of dissent from the Established Church; and the following year he preached at Norwich, where he soon attracted a numerous congregation. His unmeasured assaults upon the Church of England form of government gained for him many followers. His sect daily increasing, Dr Freake, bishop of Norwich, with other ecclesiastical commissioners, called him before them. Being insolent to the court, he was committed to the custody of the sheriff's officer, but was released at the intercession of his relative the Lord Treasurer Burghley. Brown now left the kingdom, and with permission of the States, settled at Middleburg in Zealand, where he formed a church after his own plan, and preached without molestation. The removal of persecution, however, broke up the unity of the party; numerous sects appeared, and Brown soon returned to England. He fixed his residence at Northampton, where, for his indiscreet attempts to gain proselytes, he was cited by the bishop of Peterborough, and, refusing to appear, was finally excommunicated for contempt. The solemnity of this censure, we are told, immediately effected his reformation. He moved for absolution, which he obtained, and from that time became a dutiful member of the Church of England. This happened about the year 1590; and, in a short time afterwards, Brown was preferred to a rectory in Northamptonshire, where he kept a curate, and where he might probably have died in peace; but having some dispute with the constable of his parish relative to the payment of rates, he proceeded to blows, and was afterwards so insolent to the justice, that he was committed to Northampton jail, where he died in 1630, aged eighty. Brown boasted on his death-bed that he had been confined in thirty-two different prisons. He wrote a *Treatise of Reformation without tarrying for any*, and two other pieces, making together a thin quarto, published at Middleburg in 1582. See BROWNISTS.

BROWN, ROBERT, a celebrated botanist, who may be said to be the founder of the modern science of vegetable physiology, and to have placed the natural system of the classification of plants, originally introduced by Jussieu, upon that sure and ever-widening basis on which it has ever since remained. With the exception of the early years of his life his career was uneventful. His private life is little known; and though his researches were familiar to the learned members of nearly all the European and American academies, which numbered him among their members, his very existence, until the journals of the day proclaimed his decease, was almost unsuspected by the fashionable world of the great city in which he had passed upwards of half a century. His biography may be best read in his works,—a very few words sufficing to record the salient points of his life. Robert Brown was the second and only surviving son of the Rev. Jas. Brown, Episcopalian minister of Montrose, by Helen, daughter of the Rev. Robert

Taylor, and was born on the 21st December 1773. He was educated at the grammar school of his native town, where he had as contemporaries, among others less known to fame, Joseph Hume and James Mill. In 1787 he entered Marischal College, Aberdeen, where he soon distinguished himself. Two years afterwards, his father quitting Montrose for Edinburgh, Brown removed to the university of that city, and there continued his studies for several years, but without taking a degree, though destined for the medical profession. In 1791 his father died, and in 1816 his mother; both are interred in the Canongate churchyard, in the burying ground belonging to Bishop Keith. It was about 1790 that young Brown's taste for botany attracted the attention of Dr Walker, then professor of natural history in the university. His first contribution to the science of which he was destined to be so eminent a cultivator was made on the 26th June 1792, in the shape of a paper on the plants of Forfarshire, read before the Natural History Society; the MS. is still contained in the archives of the Royal Physical Society (*Journal of Botany*, 1871, p. 321). During his student days he also discovered many plants new to Scotland, which were communicated to Withering for his *Arrangement of British Plants*.

In 1795 he obtained a commission in the Forfarshire regiment of Fencible Infantry as "ensign and assistant surgeon," and while serving in the North of Ireland steadily pursued his botanical studies, and had the advantage of the companionship of Capt. Dugald Carmichael of Appin, afterwards well known as an investigator of the lower orders of plants. Having occasion to pass several months of 1798 and of subsequent years in London, he studied in the library and museum of Sir Joseph Banks, P.R.S., whose acquaintance he had been fortunate enough to make by the discovery of a rare moss, *Glyphomitrion Daviesii*. The result of this friendly intercourse was that he was recalled from Ireland, and in the summer of 1801 quitted his not altogether congenial medico-military pursuits, to take the more agreeable post of naturalist to the expedition fitted out under Capt. Flinders for the survey of the then almost unknown coasts of New Holland. Ferdinand Bauer, afterwards familiarly associated with Brown in his botanical discoveries, was draughtsman; Wm. Westall was landscape painter; and among the midshipmen was one afterwards destined to rise into fame as Sir John Franklin. The narrative of that expedition is part of the biography of its botanist. In 1805 the expedition returned to England, having obtained, among other acquisitions, nearly 4000 species of dried plants, many of which were new. Brown was almost immediately appointed librarian of the Linnean Society, of which learned body he had been an associate since 1798, and to the presidency of which he afterwards attained. In this position, though one of no great emolument, he had abundant opportunities of pursuing his studies; but it was not until 1810 that the first volume of his great work, in Latin, the *Prodromus Floræ Novæ Hollandiæ et Insulæ Van Diemen*, appeared. It at once revolutionized systematic botany, not only by the great number of new species it described, but also by the novel views of the general affinities of plants which were promulgated in its pages. Almost immediately it took the rank it has ever since maintained as one of the canons of botanical science. Humboldt soon after its publication dedicated his well-known work on the plants of the New World to Brown (*Roberto Brownio, Britanniarum gloriæ atque ornamento, totam Botanices Scientiam ingenio mirifico complectanti*), and long after, in his *Kosmos*, styled him *facile princeps botanicorum*. The *Prodromus* is now rare in its original edition, the author having suppressed it, hurt at the *Edinburgh Review* having fallen foul of its Latinity; it is chiefly known through a German reprint. With the exception of a supplement published in 1830, no more of the work appeared. In 1810 Brown became librarian to Sir Joseph Banks, who on his death in 1820 bequeathed to him the use and enjoyment of his library and collections for life. In 1827 an arrangement was made by which these were transferred to the British Museum, with Brown's consent and in accordance with Sir Joseph's will. Brown now became keeper of this new botanical department, an office which he held until his death thirty years afterwards. Soon after Banks's decease he resigned the librarianship of the Linnean Society, and in 1849 became president, in which office he continued until 1853. His subsequent life was occupied with numerous brilliant discoveries and researches in vegetable anatomy, physiology, and classification; these are familiar to every student, and may be read in any botanical text-book. Long before his death they secured his fame as the first botanist of the day. Honours flowed thickly in upon him. In addition to being a fellow of the Royal Society he received its Copley Medal in 1839. In 1833 he was elected one of the five foreign associates of the Institute of France,—the other competitors, nearly all of whom afterwards attained the same honour, being Bessell, Von Buch, Faraday, Herschel, Jacobi, Meckel, Mitscherlich, Œrsted, and Plana. He was also a member of nearly all the learned societies and academies of this and other countries, D.C.L. of Oxford, LL.D. of Edinburgh, and knight of numerous orders, among others of the Order "pour le Mérite" of Prussia. In the "Academia Cæsarea Naturæ Curiosorum" he sat under the cognomen of Ray.

On the 10th June 1858 he died in the 85th year of his age, in his house in Soho Square, bequeathed to him by Sir Jos. Banks. His place in botanical science has long been fixed; it is not necessary now to discuss it. His works are all standards, being distinguished by their thoroughness and conscientious accuracy, and displaying powers at once of minute detail and of broad generalization, —qualities rarely combined. Indeed, so careful was he in preparing his discoveries for the press that he directed in his will that, should any of his writings be republished, they should be printed *verbatim et literatim*. In private life he was exceedingly modest, and he shrank from notoriety of every kind. Sensationalism and self-seeking he despised; fame came to him unsought. His reserved manner to those not intimately acquainted with him could never make him universally popular; but few will deny his warm-heartedness to his friends, the singleness of his purpose, and the purity of his life. Those who knew him in his most intimate relations bear witness that in mind he was simple, truthful, and upright, and that he was wise and faithful in council.

In 1825–34 Dr Brown's works up to that date were collected and published in four divisions by Nees von Esenbeck, in German, under the title of *Vermischte botanische Schriften* (Leipsic and Nuremberg). In 1866 the Ray Society reprinted, under the editorship of his friend and successor in the keepership of the Botanical Department of the British Museum, Mr J. J. Bennet, his complete writings, the *Prodromus* alone excepted. In these *Miscellaneous Works* (2 vols., with atlas of plates), the history of his discoveries can be best followed. No special biography of him is ever likely to appear, as his career contained few of the elements essential to a continuous narrative of general interest. In the necrologies of the societies and academies which numbered him among their members, there will, however, be found sketches of his life more or less complete.

BROWN, Samuel, chemist, poet, and essayist, was born at Haddington on the 23d February 1817, and died 26th September 1856. He was the son of Dr Samuel Brown, the founder of itinerating libraries, and grandson of the author of the *Self-Interpreting Bible*. In 1832 he entered the university of Edinburgh, and almost from the first devoted himself with passionate enthusiasm to the study of chemistry. The ultimate problems of the science spe-

cially attracted his attention, and he came to be persuaded that elements usually regarded as chemically simple and primary were transmutable into each other. Believing that he could demonstrate this in the case of carbon and silicon, he became a candidate for the chair of chemistry in Edinburgh university in 1843; but he withdrew his application on finding his proof inconclusive. In 1849 he delivered in Edinburgh a series of lectures of great value on the history of chemistry from the earliest times to Lavoisier. In 1850 he published the tragedy of *Galileo*, which had considerable merit. He was also an occasional contributor of articles on general literature as well as on subjects connected with his favourite science to the leading reviews. His time, however, was chiefly spent in his laboratory; and at the date of his death in 1856 he believed that he was within a very little of demonstrating the great fundamental theory in which his own faith had never wavered. Though his work was thus left incomplete, he did enough to entitle him to a place in the foremost rank of those who have cultivated the higher chemistry. An interesting collection of his essays and papers, which display general literary power of a very high order, was published in two volumes in 1858.

BROWN, THOMAS, of facetious memory, as Addison designates him, was the son of a farmer at Shiffnal in Shropshire, and was born in 1663. He was entered at Christ Church College, Oxford, whence he was soon obliged to abscond on account of the irregularities of his life. He was for some time schoolmaster at Kingston-on-Thames, and afterwards went to London, where he had recourse to the usual refuge of half-starved wits—scribbling for bread. He published a great variety of poems, letters, dialogues, &c., full of humour and erudition, but coarse and indelicate. Though a good-natured man, he had the unhappy quality of preferring rather to lose his friend than his joke. He died in 1704, and was interred in the cloister of Westminster Abbey. An incomplete edition of his works was published in 1707, in 4 vols. 12mo.

BROWN, DR THOMAS, one of the most original and subtle of Scottish psychologists, was born on the 9th January 1778, at Kirkmabreck, Kirkcudbright, of which parish his father was the clergyman. In 1780 the family removed to Edinburgh, but he was not placed at any of the schools in that city. At the age of seven he was sent to London, and began his regular education at a school in Camberwell, from which he was soon afterwards removed to Chiswick. At Chiswick he was thoroughly grounded in classics, and began to give promise of great ability, particularly in the department of verse composition, one of his school poems being deemed worthy of insertion in a magazine. He was a boy of a refined, gentle nature, intensely studious, a devourer of literature of all kinds, and much loved by his companions. After attending two other schools at Bromley and Kensington, he returned to Edinburgh, and in 1792 began his course at the university by joining the logic class, then conducted by Professor Finlayson. During the summer of 1793 he made acquaintance with Dugald Stewart's *Philosophy of the Human Mind*, and found himself irresistibly attracted towards metaphysical speculation. He joined Stewart's class, that of moral philosophy, in the following session, and quickly introduced himself to the professor's notice by reading to him a paper of objections to one of his theories, marked by great acuteness and ability. His attendance on the classes at the university seems to have been somewhat desultory; it does not appear that he ever passed through the regular curriculum of arts studies. But he carried on his reading with great vigour, and while still a student made his first appearance in the arena of philosophical disputation. His attention had been drawn towards Darwin's *Zoonomia*, which was then exciting a lively sensation in the literary world. His remarks on this book were published in 1798, and were received with great approval as one of the best and most mature examinations of the theory. His next contribution to literature was an article in the second number of the *Edinburgh Review* on the philosophy of Kant. It is acute, like all that Brown ever wrote, but it shows neither sufficient knowledge nor adequate appreciation of the philosopher it handled. Meantime he had been devoting himself to the study of medicine, having relinquished that of law, to which for a while he had applied. His graduation thesis, *De Somno*, which was thought worthy of being published, is a fine piece of psychologico-medical analysis. A few months later appeared two volumes of his poems, which were not received with much favour. Nor did his later poetical efforts attain much popularity, with the partial exception of the *Paradise of Coquettes*. They all show refined feeling and sweetness of diction, but they are wanting in the elements of true poetry. They are faint echoes of Akenside and Beattie, neither of whom can stand much dilution. Brown's real strength lay altogether in metaphysical analysis, and a favourable opportunity for calling it forth soon presented itself. Some captious objections had been raised against the appointment of the celebrated Leslie to the professorship of mathematics, on the ground that he had approved of Hume's doctrine of causality. The Humian theory was believed to lead inevitably to scepticism and infidelity, and these consequences were, of course, charged upon Leslie. Brown undertook the defence not of Leslie but of Hume, and in his examination of Hume's doctrine showed that in reality the theory was in no way inimical to the interests of true religion or theology. This examination, at first but a pamphlet, swelled out in its third edition (1818) into a bulky treatise, *Inquiry into the Relation of Cause and Effect*, containing not merely a criticism of Hume, but an elaborate theory of the causal relation. This relation Brown regards as nothing but constancy of antecedence and sequence, while at the same time he admits an intuitive belief in the permanency or universality of the causal connection. The work is a fine specimen of Brown's faculty of analysis, which it exhibits in its very best aspect.

As early as 1806 Dr Brown had engaged in practice as a physician, having been received into partnership with Dr Gregory; but though very successful in his profession, he was by nature more strongly attracted towards a literary life. He had twice failed in his application for a professorship in the university of Edinburgh, when in the session 1808–9 he was called upon to deliver a few lectures to the class of moral philosophy, in consequence of the temporary illness of Dugald Stewart. In the following year, Stewart's health still incapacitating him from active exertion, Dr Brown delivered the lectures for the greater part of the session. His success in conducting the class was unequivocal; the enthusiasm of the students was such as one reflects on with a little wonder. They were fascinated not more by the splendid rhetoric of the lecturer than by the novelty and ingenuity of the views presented. In the summer of 1810 it was resolved to appoint Brown as colleague to Dugald Stewart, and in the ensuing session he began his course as professor of moral philosophy. During the few remaining years of his life he published only his poems, but he was busily engaged in preparing an abstract of his lectures to serve as a handbook for the class. His health, never strong, gave way completely under the pressure of his work. A voyage to London, which had been recommended, proved of no avail, and he died on the 2d April 1820, at the early age of forty-two. After his death were published the first part of his proposed text-book, *Physiology of the Human Mind*, and the *Lectures on the Philosophy*

of the Human Mind, 4 vols., of which the *Physiology* is an abstract. The fame achieved by the *Lectures* when published surpassed even what they had attained when delivered. It is no exaggeration to say that never before or since has a work of metaphysics been so popular. In 1851 the book had reached its 19th edition in England, and in America its success was perhaps greater. Since that time, however, its popularity has declined with almost equal rapidity; judgments on its merits are now as severe as they were formerly favourable, and the name of Brown may be said to be a dead letter in the annals of philosophy. It is interesting to inquire how far this extravagant laudation and neglect are justifiable; and it is of importance to know exactly what were Brown's contributions to mental science, and how far his system is consistent and true.

Some part of Brown's popularity is no doubt to be accounted for from the fact that he was the leader of a revolt against the established system of philosophical thought in Scotland. It had come to be looked upon as established that in the common sense philosophy of Reid alone were metaphysical truth and soundness to be found. Brown not only showed that in many points of detail the earlier Scottish psychology was in fault, above all in their crucial doctrine of perception, but changed the whole aspect of the science by treating it from a thoroughly new and original standpoint. Still more of his fame was due to the lively impression made by his brilliant rhetorical powers. It was a novelty to find the most subtle analysis expounded in the most richly poetical language. Philosophical diction had been dry enough in Reid, and though Dugald Stewart was a master of literary exposition, his eloquence was of a chaste and elegant kind. Brown's, on the other hand, is florid and ornamental to excess, and one soon wearies of the copious quotations from poets like Akenside, Beattie, or Young. Yet the style had, and still has, a certain fascination. But in addition to these extraneous causes, one cannot help acknowledging as the main reason for Brown's quick accession to fame, his undeniable acuteness and originality. His mind was extraordinarily quick and active; there is not one of his lectures which does not contain either some addition to the older doctrine, or some new and striking application of it. What a mind of such fertility and subtility might have achieved had the thinker been spared a little longer, it would be hard to say. But it must not be forgotten in estimating his merits, that we possess only part of his system, and that he had not brought his psychology to bear upon the deeper problems of metaphysics.

Of positive contributions made by him to mental science, the following are perhaps the most important:—(1.) General conception of the object and method of psychology. According to him mental phenomena are to be treated by the recognized methods of physical science. Complex mental facts are to be resolved into their simple elements; and sequences of such facts are to be analyzed so as to bring out the general laws of their connection. Analysis is thus the one instrument to be employed. (2.) View of mental processes and rejection of the ordinary doctrine of faculties. Just as physical science has to analyze and trace the connections of the various phenomena or modes of appearance of matter, without ever reaching the essence which lies behind them, so psychology treats all mental facts as *states* or *modes* or *modifications* of the mind. Perceptions, abstractions, *emotions*, or desires are simply the mind in the several states of perceiving, abstracting, feeling, or desiring. The so-called faculties are nothing but the various modes in which mental activity manifests itself. Consciousness is not to be distinguished from the several mental states. Mental modifications may be classified according to what gives rise to them; they spring up either after some internal cause, or after some other mental mode. In the first case they may be called external states, in the second, internal. The internal may be again divided into intellectual and emotional. (3.) Analysis of touch into touch proper and the muscular sense. This is perhaps the most valuable of Brown's contributions. There are no doubt anticipations of the division, particularly in De Tracy, whom Brown had studied, but his originality is, we think, beyond question. The analysis has since been carried out much more perfectly than by Brown. (4.) Theory of extension. Brown was one of the first to attempt the resolution of our knowledge of extension into a series of muscular feelings, successive in time. His analysis is exceedingly acute, though in many points it must now be looked upon as erroneous. (5.) Doctrine of perception. According to him, all that we *know* of the external world consists of the feelings of resistance, outness, and extension, which are combined into one complex state; but our intuitive belief in the causal principle compels us to postulate a real existence as lying behind and giving rise to these feelings. (6.) Prominence given to the doctrine of suggestion or association. All internal intellectual states may be reduced to simple suggestions, *i.e.*, where one state arises in consequence of another, and to relative suggestion, where the relation between two states gives rise to a third state. Brown analyzes with great skill the powers of suggestion or association, and illustrates very fully the primary and secondary states. Under the head of relative suggestion, he discusses at great length the perception of resemblance or similarity, and draws out an elaborate theory of generalization, intended to supplement the defective view of the Nominalist and to reduce to its proper sphere the supposed abstract idea of the Conceptualist. The analysis was highly popular in its time, but has little of real novelty in it. (7.) Ethical doctrine. To this Brown added little; indeed, the weakest part of his psychology is that bearing upon the will, which he identifies with desire. With regard to conscience, he postulates the existence of a primitive susceptibility to moral emotion; *i.e.*, a certain ethical feeling is infallibly excited by those actions of agents which are right or wrong.

On the whole, it will be seen from this brief statement of what was new in Brown's philosophy, that it occupies an intermediate place between the earlier Scottish school and the later analytical or associational psychology. To the latter Brown really belonged, but he had preserved certain doctrines of the older school which were out of harmony with his fundamental view. He still retained a small quantum of intuitive beliefs, and did not appear to see that the very existence of these could not be explained by his theory of mental action. This intermediate or wavering position accounts for the comparative neglect into which his works have now fallen. They did much to excite thinking, and advanced many problems by more than one step, but they did not furnish a coherent system, and the doctrines which were then new have since been worked out with greater consistency and clearness.

For a severe criticism of Brown, see Sir W. Hamilton's *Discussions* and *Lectures on Metaphysics*; and for a high estimate of his merits, see J. S. Mill's *Examination of Hamilton*. The only German writer who seems to have known anything of Brown is Beneke, who found in him anticipations of some of his own doctrines. See *Die Neue Psychologie*, pp. 320–330. (R. AD.)

BROWN, Ulysses Maximilian, a celebrated general in the imperial armies, son of Ulysses, Baron Brown and Camus, a colonel of cuirassiers, was descended of an ancient Irish family, and was born at Basel in 1705. After studying at Limerick, Rome, and Prague he entered the army, becoming in 1723 captain in the regiment of his uncle, Count George Brown, and in 1725 lieutenant-colonel. He served with great distinction in Corsica and Italy, and in 1739 was made field-marshal-lieutenant, and counsellor in the aulic council of war. After the death of the Emperor Charles VI. he became one of the foremost generals in the army of the Empress-Queen Maria Theresa, and gained a high reputation for military skill. On the outbreak of the Seven Years' War, Count Brown, with the rank of field-marshal, assembled his army in Bohemia, and repulsed the Prussians at the battle of Lowositz. He was mortally wounded at the great battle of Prague, and was carried into the town, where he expired on the 20th June 1757.

BROWN, William Laurence, born at Utrecht, January 7, 1755, was the son of the Rev. William Brown, minister of the English church in that city. The father, having been appointed professor of ecclesiastical history at St Andrews, returned to Scotland in 1757, and his son was in due time sent to the grammar school of that city. At the age of twelve he entered the university, and after passing through the classes of divinity, removed in 1774 to the university of Utrecht, where he combined with the study of theology that of the civil law. In 1777 he was appointed to the charge of the English church in Utrecht, which had been previously held by his father and uncle. About 1788 he was appointed to the professorship of moral philosophy and ecclesiastical history in the university of Utrecht, to which was soon added the professorship of the law of nature. The war which followed the French Revolution finally drove Dr Brown from the place of his nativity. In January 1795 he made his escape to England. In London he experienced such a reception as was due to his literary talents and moral worth; and in 1795 the magistrates of Aberdeen appointed him to the chair of divinity on the retirement of Dr George Campbell, and soon after he

was made principal of Marischal College. In the year 1800 he was appointed chaplain in ordinary to the king, and in 1804 dean of the chapel royal, and of the Order of the Thistle. He died on the 11th of May 1830, in the seventy-sixth year of his age.

His most widely known works were an *Essay on the Natural Equality of Men*, 1793, which gained the Teyler Society's prize; a treatise *On the Existence of the Supreme Creator*, 1816, to which was awarded the first Burnet prize of £1250; and *A Comparative View of Christianity, and of the other Forms of Religion which have existed and still exist in the World, particularly with regard to their Moral Tendency*, 1826.

BROWNE, Charles Farrar, an American humorous writer, best known under his *nom de plume* of Artemus Ward, was born at Waterford, Maine, in 1834. He began life as a compositor and occasional contributor to the daily and weekly journals. In 1858 he published in the Cleveland *Plaindealer* the first of the "Artemus Ward" series, which in a collected form attained great popularity both in America and England. In 1860 he became editor of *Vanity Fair*, a humorous New York weekly, which proved a failure. About the same time he began to appear as a lecturer, and by his droll and eccentric humour attracted large audiences. In 1866 he visited England, where he became exceedingly popular both as a lecturer and as a contributor to *Punch*. In the spring of the following year his health gave way, and he died of consumption at Southampton on the 6th March 1867. For a critical estimate of his works see the article American Literature, vol. i. p. 728.

BROWNE, Isaac Hawkins, an English poet, was born in 1705 at Burton-upon-Trent, of which place his father was minister. He received his grammatical instruction first at Lichfield, and then at Westminster, whence, at sixteen years of age, he was removed to Trinity College, Cambridge, of which his father had been fellow. After taking his master's degree he removed to Lincoln's Inn, where he applied closely to the study of the law. Not long after the commencement of his professional studies, he wrote a poem on *Design and Beauty*, which he addressed to his friend Highmore the painter. Here also he wrote his most popular poem, entitled *The Pipe of Tobacco*, in which he gave imitations of Cibber, Ambrose Philips, Thomson, Young, Pope, and Swift, who were then all living. In 1744 he married the daughter of Dr Trimnell, archdeacon of Leicester. He was elected in 1744 and again in 1748 to serve in parliament for the borough of Wenlock in Shropshire, near which place he possessed a considerable estate, left to him by his maternal grandfather. In 1754 he published his poem *De Animæ Immortalitate*, in which, besides a judicious choice of matter and arrangement, there is thought to be a happy imitation of Lucretius and Virgil. The wide popularity of this poem produced several English translations of it, the best of which is given by Soame Jenyns, in his *Miscellanies*. The author intended to have added a third book, but of this he had left only a fragment. He died, after a lingering illness, in 1760. In 1768 his son published an elegant edition of his poems, in large octavo.

BROWNE, James, LL.D., man of letters, for a number of years sub-editor of the seventh edition of the *Encyclopædia Britannica*, was born at Coupar-Angus in 1793. He was educated at Edinburgh and afterwards removed to St Andrews, where he studied for the church. He wrote *The History of Edinburgh* for Ewbank's Picturesque Views of that city, 2 vols., 1823–25. In 1826 he became a member of the Faculty of Advocates, and obtained the degree of LL.D. from King's College, Aberdeen; and in this same year he published a *Critical Examination of Macculloch's Work on the Highlands and Islands of Scotland*. In 1827 he published at Paris his *Aperçu sur les Hieroglyphes d'Egypte*; and in the following year there appeared his *Vindication of the Scottish Bar from the Attacks of Mr Brougham*. He was now appointed editor of the *Caledonian Mercury*; and two years later he became sub-editor of the *Encyclopædia Britannica*, to which he contributed a large number of valuable articles. He also published in 1838 a *History of the Highlands and Highland Clans*, 4 vols. 8vo, of which various editions have since appeared. His mental activity was remarkable, and frequently urged him to exertions beyond his strength. He died in 1841, from a stroke of apoplexy, brought on by his unremitting labours.

BROWNE, Peter, bishop of Cork and Ross, an able writer on theology, was born in Ireland some time after the Restoration. He entered Trinity College, Dublin, in 1682, and after ten years' residence obtained a fellowship. In 1699 he was made provost of the College, and in the same year published his *Letter in answer to a Book entitled "Christianity not Mysterious,"* which was recognized as the ablest reply yet written to Toland. It expounds in germ the whole of his later theory of analogy. In 1710 he was made bishop of Cork and Ross, which post he held till his death in 1735. In 1713 he had become somewhat notorious from his violent onslaught on the fashion of drinking healths, a polemic which he carried on in several pamphlets. His two most important works are the *Procedure and Limits of the Human Understanding*, 1728, an able though sometimes captious critique of Locke's essay, and *Things Divine and Supernatural conceived by Analogy with Things Natural and Human*, more briefly referred to as the *Divine Analogy*, 1733. The doctrine of analogy was intended as a reply to the deistical conclusions that had been drawn from Locke's theory of knowledge. Browne holds that not only God's essence, but his attributes are inexpressible by our ideas, and can only be conceived analogically. This view was vigorously assailed by Berkeley in his *Alciphron* (Dialogue IV.), and great part of the *Divine Analogy* is occupied with a defence against that criticism. The bishop emphasizes the distinction between metaphor and analogy; though the conceived attributes are not thought as they are in themselves, yet there is a reality corresponding in some way to our ideas of them. The doctrine of analogy is interesting, and has an interesting history in English theology. Its most logical expression may be found in the *Bampton Lectures* of the late Dean Mansel.

BROWNE, Sir Thomas, a distinguished English writer, was born in London on the 19th October, 1605. He was educated at Winchester School, and afterwards at Broadgate Hall (Pembroke College), Oxford, where he graduated B.A. in January 1626. He took the further degree of M.A. in 1629, studied medicine, and practised for some time in Oxfordshire. Between 1630 and 1633 he left England, travelled through Ireland, France, and Italy, and on his way home received the degree of M.D. at the university of Leyden. He returned to London in 1634, and two years later, after a short residence in Yorkshire, settled in practice at Norwich. In 1642 a copy of his *Religio Medici* was printed from one of his MSS. without his knowledge, and he was compelled to put forth a correct edition of the work, which appears to have been composed as early as 1634. Its success was very great, and the author at once became celebrated as a man of letters. In 1646 appeared his *Pseudodoxia Epidemica*, or *Enquiries into Vulgar and Common Errors*, which added to his fame. In 1658, on the occasion of the discovery of some ancient urns in Norfolk, he wrote his *Hydriotaphia* or *Urnburial*, to which was appended *The Garden of Cyrus*. These four works were all that he published, though several tracts,

notably the *Christian Morals* and *Antiquities of Norwich*, were prepared for publication, and appeared after his death. In 1671 he received the honour of knighthood from Charles II. on his visit to Norwich; and in 1682 he died on his seventy-seventh birthday.

Browne is in every way a remarkable and peculiar writer. His writings are among the few specimens of purely literary work produced during a period of great political excitement and discord. England was passing through its greatest convulsion; events of mighty moment were being transacted round him, and he remained placidly indifferent. While the grandest minds of his country were busied with the important affairs of state, he was revising his *Religio Medici*, and his book was published in the very year in which the civil war broke out. While England was torn with civil discord, and the liberty of her children was being bought with their blood, Browne serenely pursued his studies at Norwich, to all appearance as indifferent to contemporary events as if he had belonged to another planet. Just when there came a lull in the conflict, when the royal power was broken, and the air was filled with doubts, anxieties, and negotiations, Browne published his *Pseudodoxia Epidemica*. The death of the king, the expulsion of the parliament, the establishment of the protectorate, passed by him like a breath which he heeded not. But the unearthing of some sepulchral urns at once roused his attention, and furnished occasion for a train of most magnificent and majestic reflections on the short space of human life, on the signs and symbols of mortality. A mind like this is a psychological curiosity, and its peculiarities are faithfully reflected in the form and matter of his works. In some respects, of course, he resembles his contemporaries; in his, as in all other writings of the 17th century, there is a plentiful display of erudition, copious citation of authorities, and lavish quotation from older writers. Some part also of the peculiarity of his style may be ascribed to the general tendency of the language at that period. It was a time of unusual richness of diction; great writers did not hesitate to coin words and phrases as occasion required them, and ample raw material was supplied by the great mass of literature, which had been but recently opened up, and which was then being assimilated. But Browne stands apart from his contemporaries by reason of the peculiar and unique cast of his mind. Deeply speculative, imbued with the Platonic mysticism which taught him to look upon this world as only the image, the shadow of an invisible system, he regarded the whole of experience but as food for contemplation. Nothing is too great or too small, too far removed or too near at hand for him; all finds a place in the universe of being, which he seems to regard almost from the position of an outsider. His general mood may be characterized as the metaphysical; not that he speculated systematically on the problems of existence, but because he dwells repeatedly, and with evident delight, upon what transcends the little sphere of our life, and, like Shakespeare, is fond of meditating on the outward and visible signs of mortality, and on what lies beyond the grave.

Of Browne, however, as of our greatest writers, it is true that the style is the man. The form of his thought is as peculiar and remarkable as the matter; the two, indeed, react upon one another. It is a style altogether unique,—rich, with a lavish use of metaphor and analogy—majestic and swelling, and with a fine antique flavour about it. Much of its quaintness, no doubt, depends on the excessive employment of Latinized words, great part of which have never succeeded in making their way into the standard language; but the peculiarities of the vocabulary do not entirely exhaust those of the style. Of his four masterpieces the *Religio Medici* is that in which we are most in contact with the writer himself. The book was a puzzle to contemporaries, and is still hard to understand. It is the confession of faith of a mind keen and sceptical in some aspects, but on the whole deeply imbued with the sense of the mysteriousness of true religion, and willing to yield itself up without reserve to the requirements of faith. "I love," he says, "to lose myself in a mystery, to pursue my reason to an *O, Altitudo!*" The *Vulgar Errors* is a wonderful storehouse of out-of-the-way facts and scraps of erudition, exhibiting a singular mixture of credulity and shrewdness. The style is more direct and simple than in the other works. The *Garden of Cyrus* is a continued illustration of one quaint conceit. The whole universe is ransacked for examples of the *Quincunx*, and he discovers, as Coleridge says, "quincunxes in heaven above, quincunxes in earth below, quincunxes in the mind of man, quincunxes in tones, in optic nerves, in roots of trees, in leaves, in everything!" But the whole strength of his genius and the wonderful charm of his style are to be sought in the *Urnburial*, the concluding chapter of which, for richness of imagery and majestic pomp of diction, can hardly be paralleled in the English language. For anything at all resembling it we must turn to the finest passages of Jeremy Taylor or of Milton's prose writings.

The best edition of Sir T. Browne is that by Simon Wilkin, 4 vols., 1836,—3 vols. (Bohn), 1851, where full biographical and bibliographical information will be found. Prefixed to it is Johnson's celebrated *Life*.

BROWNE, William, an English poet, descended of a good family, was born at Tavistock in Devonshire, in 1590. Having passed through the grammar school of his native place, he was sent to Exeter College, Oxford, and became tutor to Robert Dormer, afterwards earl of Carnarvon. After having received in 1624 the honorary degree of M.A., he was taken into the family of William, earl of Pembroke, and improved his fortune so much that he is said to have purchased an estate. Nothing seems to be known of his after life, and no date has ever been given for his death. All his work was done in his youth, the first part of *Britannia's Pastorals* having been published in 1613, *The Shepherd's Pipe* in 1614, and the second part of the *Pastorals* in 1616. He belongs to the school of Spenser, and his merits may be summed up briefly as extreme sweetness of verse, idyllic nature-painting, and richness of descriptive faculty. The *Pastorals* are about the finest specimens we have in earlier literature of luxuriant sensuous description of ordinary country life. They were highly popular in their time. (See Wood, *Athen. Oxon.*)

BROWNE, William George, an eminent traveller, was born at Great-Tower-Hill, London, July 25, 1768. At seventeen he was sent to Oriel College, Oxford. Having had a moderate competence left him by his father, on leaving the university he applied himself entirely to literary pursuits. But the fame of Bruce's travels, and of the first discoveries made by the African Association, determined him to become an explorer of Central Africa. Accordingly, he left England at the close of 1791 and arrived at Alexandria in January 1792. He spent a few months in visiting Siwah, the supposed site of the temple of Jupiter Ammon, and employed the remainder of the year in examining the whole of Egypt. In the spring of 1793 he visited Suez and Sinai, and in May set out for Darfûr. This was his most important journey, in which he acquired a great variety of original information. He endured much hardship, and was unable to effect his purpose of returning by Abyssinia. He did not reach Egypt till 1796; after this he spent a year in Syria, and did not arrive in London till September 1798. In 1800 he published his travels in Africa, Egypt, and Syria, from the year 1792 to 1798, in one volume 4to. The work was highly esteemed, and is classed by Major Rennell

among the first performances of the kind; but, from the abruptness and dryness of the style, it never became very popular. In 1800 Browne again left England, and spent three years in visiting Greece, some parts of Asia Minor, and Sicily. In 1812 he set out on a more extensive journey, proposing to penetrate to Samarkand, and survey the most interesting regions of Central Asia. He spent the winter in Smyrna, and in the spring of 1813 proceeded through Asia Minor and Armenia, made a short stay at Erzeroum, and arrived on the 1st of June at Tabriz, where he met Sir Gore Ouseley. About the end of the summer of 1813 he left Tabriz for Teheran, intending to proceed thence into Tartary; but unhappily he never reached that destination. Near the banks of the Kizil-Ouzen his party were attacked by banditti, and, according to the report of the survivors, Browne was plundered and murdered. Suspicion attached to his companions, and even to the Persian Government, but nothing occurred to confirm these surmises. Some bones, believed to be his, were afterwards found and interred near the grave of Thevenot, the celebrated French traveller. His volume of travels in Africa has already been mentioned. Robert Walpole published in the second volume of his Memoirs relating to European and Asiatic Turkey (4to, 1820), from papers left by Browne, the account of his journey in 1802 through Asia Minor to Antioch and Cyprus; also "Remarks written at Constantinople."

BROWNING, Elizabeth Barrett, the most distinguished poet of her sex that England has produced, was born in London in the year 1809. She was the daughter of Mr Barrett, an English country gentleman. From a very early age, almost before the years of childhood had passed, she exhibited a remarkable preference for the arts, but especially that of the poetic. Previous to attaining her fifteenth year she had written verse upon which was the stamp of true genius—poems eminently worthy of preservation Whatever she wrote, however, was sacred to all eyes save those of her father, to whom she refers in the first collected edition of her poems as "my public and my critic." Her physical constitution was most fragile and delicate, but nature seemed to have supplemented her deficiency in this respect by bestowing upon her an unusually sensitive mental and spiritual organization. One who knew her intimately, Miss Mitford, has described her as a "slight delicate figure, with a shower of dark curls falling on each side of a most expressive face, large tender eyes, richly fringed by dark eye-lashes, and a smile like a sunbeam." All descriptions of Miss Barrett concur in this, that she possessed a grace and a delicacy which defied representation by the artist. Her studies were early directed to the poets of antiquity, and, under the guidance of her blind tutor, Boyd, whose name she always warmly cherished, she mastered the rich treasures of Æschylus The sublime Grecian possessed for her a charm which was only equalled by the fascination held over her wondering spirit by our own Shakespeare. Her knowledge of Greek literature was most profound; she was intimately familiar with all the Attic writers in tragedy and comedy. Yet this did not prevent her from drinking at the wells of English undefiled. Her correspondence with eminent contemporaries of both sexes proves her to have been thoroughly acquainted with English literature in its progress from Chaucer downwards. The circumstances of her own life, and her lack of robust health, conspired to make her seek, even more than she might have otherwise done, the communion of the great departed in arts and letters. Not being able to pass from place to place without fatigue and danger, the solitude she was compelled to maintain probably threw her still more ardently into those pursuits which, while dear to the mind, were probably injurious to the body. Most frail from her birth, as we have already seen, it was her misfortune further to have her existence endangered in 1837 by the bursting of a blood-vessel in the lungs. By the exercise of extreme care her life was preserved, but the incident was succeeded by a long period of weakness and suffering. Some two years after this first severe shock to her system, and before she had quite recovered from its effects, she was again assailed by misfortune, experiencing the keenest anguish on witnessing the death of her favourite brother, who was drowned at Torquay. As might have been expected from one of her clinging and affectionate disposition, a long period of danger followed this catastrophe, and when at length she was able to be removed to her father's house, it was only to become an invalid, with the prospect of a life couch-ridden to its close. This period of seclusion lasted for seven long years; and the interval was employed by Miss Barrett in eagerly devouring all the books which could be brought within her reach. At this time also she was sedulously cultivating the art that was afterwards to ensure for her immortality. When she was in her thirty-seventh year, that is, in 1846, she was married to Mr Browning, and the union was singularly felicitous. More cannot be said, as the author of *The Ring and the Book* still lives. Mr Browning bore his wife to Italy, and for some years the sunny skies of the south were instrumental in giving to Mrs Barrett Browning that health which had so long forsaken her in her native land. The villa of the Brownings in Florence was the resort of many noble spirits, eminent either for patriotism or in the arts. Mrs Browning died at Florence in the year 1861, after testifying in many ways her singular devotion to the country of her adoption.

The poetry of this writer is distinguished for its emotional spirit; had her imagination equalled her capacity for feeling she might have taken rank with the highest of our poets. Sensibility and intuition, those endowments of supreme importance to writers of genius, whose greatness is to grow in proportion to their understanding and interpretation of human life, were in her united in a degree seldom witnessed. The aspirations she indulged, and the character she doubtless wished to be impressed upon her own works, were well set forth when she observed on one occasion, "we want the touch of Christ's hand upon our literature as it touched other dead things; we want the sense of the saturation of Christ's blood upon the souls of our poets, that it may cry through them in answer to the ceaseless wail of the sphinx of our humanity, expounding agony into renovation. Something of this has been perceived in art when its glory was at the fullest. Something of a yearning after this may be seen among the Greek Christian poets, something which would have been much with a stronger faculty." Imbued fully with this idea of the sacredness of poetry, Mrs Browning went to the deepest fount of all inspiration—the human heart—and endeavoured to read clearly its intimate relations with God. A peculiar tenderness breathes through her writings, whether of the humblest or the most ambitious description. Almost her first work bore upon it the traces of her Greek studies, being an excellent translation of the *Prometheus*. Another very early production, *The Drama of Exile*, is unquestionably marked by great sublimity of thought, though the conception may lack the mighty outlines of the majestic Milton. Eloquent and sustained, however, the poem made manifest a pure and original writer. Mrs Browning's genius had two sides—the lyric and the dramatic. Her lyrical capabilities were of the highest order: she was greater probably in this particular than either Campbell or Tennyson, though on several occasions Campbell touched the loftiest point such a writer can attain. The heart, which has always given our lyric poets their greatest power, was the strength of Mrs Browning; her song was a living

voice, eloquent with passion. In one of her lyrics she uttered her conclusion upon the human mystery, "knowledge by suffering entereth, and life is perfected by death." The spirituality of her "Vision of Poets" is a noticeable quality, and it is in a loftier strain than that of "The Two Voices," though cast in the same mould. Wandering amongst the minor poems of Mrs Browning, such for instance as "The Romaunt of Margret," "Isobel's Child," "Bertha in the Lane," and "the Swan's Nest among the Reeds," is like standing in the forest alone, with the wailing wind and the flying rain as the only assurances of an existence sublimer than our own. Yet she has thereby reached the profoundest depths of the human heart. But even when most depressed she does not lose faith—confidence in the triumph of the good and the right. To her it was not always necessary to understand the wrong which she beheld; she saw it and hated it, and she has helped men by her writings to do something towards making an end of it. "The Cry of the Children" is a striking illustration of her keen feeling and eloquent power as a philanthropist. She felt for all who are in any way crushed or bruised by the pressure of society, and of social distinctions, or of social misfortunes. Her poetry bears the impress of tender and profound sympathy with human suffering in every form.

The range of this author's powers was wide, as may be gathered by a comparison between such poems as "A Child's Thought of God" and "Casa Guidi Windows." In the latter she attained her ripest growth and greatest intellectual strength. The poem is as sustained as anything which she ever wrote, and more perfect than the remaining lengthy poems. The "Casa Guidi Windows" had the advantage of a direct and powerful inspiration. From her windows at Florence Mrs Browning looked out upon the Italian people struggling for freedom, and her enthusiasm was enkindled. Her utterances were therefore in accordance with the fulness of her heart, lavish and unrestrained. The extraordinary wealth and strength of imagery which the poem contains must have been noticed by every reader, and it includes doubtless much of her finest writing. In the inditing of the sonnet, always conceded to be a most difficult task, Mrs Browning was very successful. She is the equal of Wordsworth in this respect, and her "Sonnets from the Portuguese" (but thinly disguised, and giving really the history of her own feelings) are a compact and remarkable series of verses. They present us with a complete study of a human heart as it is affected by the passion of love. First, there is the soul expecting death, when suddenly life is revivified by love; then the grave, which had seemed inevitable, is put behind the soul; and finally comes the sequel, the marriage of those whose history has been traced in the Sonnets. The unity and psychological interest of this series of poems are their most prominent features.

Mrs Browning's fame chiefly rests upon *Aurora Leigh*, except with diligent and reverent students of her other works. The longest poem, nevertheless, which came from her hand is the one, to quote her own words, into which her "highest convictions upon life and art have entered." Yet it has had the result of causing a wide diversity of opinion upon its merits. Extravagant encomiums or unjust aspersions are generally awarded to it. For a poem of such magnitude unity is essential, and this we find to be lacking. It has not the one purpose—never ignored and never forgotten—which runs through *In Memoriam*. One of its great charms, however, viz., its intense subjectivity, will prevent *Aurora Leigh* from falling into desuetude. The writer unfolds with great beauty of expression the truth that that is real art which assists in any degree to lead back the soul to contemplate God, the supreme artist of the universe. But notwithstanding its philosophy, as a solution for many of the problems of our social existence, the poem must be pronounced a failure. It is charged with passages of lofty poetry, though occasionally it falls into mediocrity. It is to be regarded rather as an autobiography (which indeed it claims to be) than as a poem characterized by fine conception or perfect execution. The position of Mrs Browning as a poet is now yielded. Her genius was perhaps as great as that of any poet of our generation, but circumstances retarded its highest possible development. In certain intellectual qualities she was inferior to Tennyson and the author of *Sordello*, but in others she was their superior. Be her exact niche, however, what it may, she occupies a favoured place in English literature, and is undoubtedly one of the few leading poets of the 19th century. Her poetry is that which refines, chastens, and elevates. Much of it is imperishable, and although she did not reach the height of the few mighty singers of all time, she has shown us the possibility of the highest forms of the poetic art being within the scope of woman's genius. (G. B. S.)

BROWNISTS, a religious sect, which sprang up towards the close of the 16th century, and which received its name from the first promulgator of the doctrines, Robert Brown. Their numbers increased rapidly, and Sir Walter Raleigh, in a speech in 1592, estimated them at no less than twenty thousand. The harsh measures that were taken against them, and the disgust generally excited by the tone of their attacks upon the Established church, for a time stamped out the sect in England. But the remnant found a refuge in Holland, and the church established there between 1593 and 1608 included many eminent men, such as Ainsworth, Johnson, Smyth, Jacob, Clifton, and Robinson, and gradually increasd in numbers. Soon, however, differences of opinion began to arise; some, with Smyth, carried out the principles of Brownism to their full extent, and became absolute Separatists; others, with Robinson, adopted a milder form of opposition to the church, which ultimately resulted in Independency. The stronger stream of tendency set in towards this latter form of doctrine, and the Brownists soon faded out of view and gave place to the Independents. The occasion of the Brownists' separation was not any fault they found with the faith, but only with the discipline and form of government of the other churches in England. They charged corruption equally on the Episcopal form and on that of the Presbyterians by consistories, classes, and synods; nor would they join with any other Reformed church, because they were not assured of the sanctity and regeneration of the members who composed it, on account of the toleration of sinners, with whom they maintained it an impiety to communicate. They condemned the solemn celebration of marriages in the church, maintaining that, as matrimony was a political contract, the confirmation of it ought to come from the civil magistrate. They would not administer baptism to the children of such as were not members of the church, or of such as did not take sufficient care of their children already baptized. They rejected all forms of prayer, and held that the Lord's Prayer was not to be recited as a prayer, having been given only for a rule or model whereon all our prayers are to be formed. The form of church government which they established was democratical. When a church was to be gathered, such as desired to be members of it made a confession and signed a covenant, by which they obliged themselves to walk together in the order of the gospel. The whole power of admitting and excluding members, with the decision of all controversies, was lodged in the brotherhood. The church officers were chosen from among themselves, for preaching the word and taking care of the poor, and were separated to their several offices by fasting, prayer, and imposition of hands by some of the brethren. But they did not erect the priesthood into a

distinct order. As the vote of the brotherhood made a man a minister, and gave him authority to preach the word and administer the sacraments among them, so the same power could discharge him from his office, and reduce him to the condition of a mere layman again. And as they maintained that the bounds of a church were defined by the number of those who could meet together in one place, and join in one communion, so the power of these officers was confined within the same limits. The minister or pastor of one church could not administer the Lord's Supper to another, nor baptize the children of any but those of his own society. Any lay brother was allowed the liberty of prophesying, or of giving a word of exhortation to the people; and it was usual for some of them, after sermon, to ask questions, and reason upon the doctrines which had been preached. In a word, every church on the Brownists' model is a body corporate, having full power to do everything which the good of the society requires, without being accountable to any presbytery, synod, assembly, convocation, or other jurisdiction whatever. (See Fuller, Neal, Fletcher, Hanbury, and Masson, *Life of Milton*, vol. ii. pp. 534, *seq.*)

BRUCE, James, a celebrated African traveller, was born at Kinnaird House, Stirlingshire, on the 14th December 1730. He was educated at Harrow, and at first turned his attention to the bar. After his marriage, however, he entered into business as a wine-merchant, but soon gave up any active share in the concern. His wife had died within a year of their marriage, and Bruce, after acquiring a knowledge of the Spanish and Portuguese languages, travelled on the Continent for some time, returning to England in 1758. He then made a proposal to the English Government that they should make a descent upon Spain at Ferrol, assuring them from his own observation that the coast was without defence at that place. His suggestions were not adopted; but Lord Halifax, to whom he had been introduced, and who had consulted him about the exploration of the Nile, appointed him soon afterwards to the consulship at Algiers. He arrived at that place in March 1762, and after spending a year in the study of Arabic and other Oriental languages, set out through Tunis, Tripoli, and the North of Africa. He then visited Rhodes and Cyprus, and explored great part of Syria and Palestine, making very careful drawings of Palmyra and Baalbec. These drawings were afterwards presented to the king and placed in the royal library at Kew. It was not till June 1768 that Bruce arrived at Alexandria, and prepared to start on his great exploring expedition. From Cairo he sailed up the river as far as Syene; he then struck across the desert to Kosseir, and reached Jidda in May 1769. He remained for some time in Arabia, set sail from Loheia on the 3d September, and on the 19th arrived at Massowah. There he was detained for some time; but at last, on the 15th February 1770, he made his way to Gondar, the capital of Abyssinia. He gained great favour with the Abyssinian king, and remained with him till October, when he set off up the Bahr-el-Azrek, which he looked upon as the main branch of the Nile. On the 14th November he reached the sources of the Bahr-el-Azrek, and proudly imagined himself to have solved the great geographical problem. Slowly and with great difficulty he made his way back through the deserts of Nubia. On the 29th November 1772 he reached Assouan on the Nile. Thence he returned into the heart of the desert to recover his baggage, which had been abandoned in consequence of the death of all his camels. In January 1773 he arrived at Cairo. On his way home to England he spent some time at Paris, where he was warmly received by Buffon and other eminent men of science. The celebrated *Travels* did not appear till 1790, when they were published in five large quarto volumes, profusely illustrated. The work was received with favour on account of its freshness and interest, but with almost universal incredulity. The *Travels* were looked upon as veritable travellers' tales, not entitled to any respect as authentic narrative. Succeeding investigations, however, have thoroughly dispelled these suspicions, and reinstated the book in popular estimation. Bruce died in 1794, in consequence of a fall down the staircase of his own house. A second edition of his work, on which he was engaged at the time of his death, was published in 1804.

BRUCE, Michael, a minor Scottish poet, was born at Kinnesswood, Kinross-shire, 27th March 1746, and was the son of a weaver. He was early sent to school, but his attendance was often interrupted. He had frequently to herd cattle on the hills in summer, and this early companionship with nature greatly influenced his mind and awoke the latent poetry of his genius. Delicate from birth he grew up contemplative, devotional, and humorous, the pet of his family and his friends. His parents gave him an education superior to their position; at fifteen, when his school education was completed, his father was enabled to send Michael to Edinburgh University, which he attended during the four winter sessions 1762–5. In 1765 he got employment as a teacher during the summer months at Gairney Bridge, receiving about £11 a year in fees. He became a divinity student of a dissenting Scotttish sect known as the Burghers, and in the first summer of his divinity course accepted the charge of a new school at Forrest Mill, where "he lead a melancholy kind of life." Poverty, disease, and want of companions depressed his spirits, but in that solitariness he wrote "Lochleven," a poem inspired by the memories of his childhood. In consequence of advanced consumption he had to give up the school, and returned to his father's house, where he wrote his last and finest poem, "Elegy written in Spring," and died on 5th July 1767, aged twenty-one years and three months. As a poet his reputation has been increased, first, through sympathy for his early death, and secondly, from the alleged theft by Logan of several of his poems. The Rev. John Logan, minister of Leith, a fellow-student of Bruce, edited in 1770 the *Poems on several occasions, by Michael Bruce*, in which the "Ode to the Cuckoo" appeared. In the preface he stated, "To make up a miscellany, some poems written by different authors are inserted." In a collection of his own poems in 1781, Logan printed the "Ode to the Cuckoo" as his own; of this the friends of Bruce were aware, but did not challenge it. Dr M'Kelvie, in his *Life and Works of Bruce* (1837), was the first to claim for him the authorship of the Ode, and of other verses of which Logan had hitherto been the reputed author. This claim rests on the oral tradition of his birthplace and the evidence of a few of his friends; it was made nearly fifty years after Logan's death, and no explanation can be given of this great lapse of time. Of direct testimony there is none, and irrelevant matter is brought in affecting Logan's character, while Logan's authorship rests on such ground as publication under his own name, and his reputation as author during his lifetime. By reiteration of Bruce's claims in many forms popular opinion has been gained for him, though Isaac D'Israeli, Thomas Campbell, Robert Chambers, and David Laing have strenuously supported Logan. The dispute cannot now, perhaps, be satisfactorily settled, owing to the conflict of evidence and lapse of time; but on the whole it may be doubted whether M'Kelvie has proved his case. All Bruce's poems breathe the thoughts of a shepherd lad, as Bloomfield's retained the fresh observations of a farmer's boy. With two exceptions they are immature and lack strength; his imagery is in great measure borrowed; his rhymes evince a paucity of poetical skill. His early attempts are weak imitations of Milton, Thomson, and Young, his

favourite poets. His "Lochleven" and "Elegy written in Spring" are alone worthy of preservation, and both were composed in his last year. The former abounds in happy word-painting and moral reflections. The tale of Levina, which forms about the half of the poem, and is by far the prettiest flower in the bouquet, bears distinct marks of the same hand that wrote "Runnimede." The "Elegy" is most affecting, when read in the knowledge of the circumstance of its having been written by a dying youth of twenty-one:—

> "Led by pale ghosts I enter death's dark gate,
> And bid the realms of light and life adieu."

It is a death song, remarkable for exquisite beauty and chaste simplicity. Bruce is not to be compared with another young Scottish poet, Robert Nicoll. His life wanted the fulness and strength, his poems the wide and vivid sympathies of his later compeer.

BRUCE, Robert, king of Scotland. See Scotland.

BRUCHSAL, a town of the Grand Duchy of Baden, in the circle of Carlsruhe, 14 miles from the city of that name, on the Salzbach. From 1056 to 1801 it was the seat of the bishop of Spires, whose magnificent palace is still extant; and it has an old castle of the 12th century (now used as a prison), a town-house, a gymnasium, a hospital, barracks, and a considerable trade in wine. Population in 1872, 9762. The town was originally the seat of an imperial palace, and its name is said to be derived from *bruch* a marsh, and *sala*, royal possession. The Peasants' War first broke out at Bruchsal, which has been several times reduced to ashes in subsequent conflicts. In 1849 it was the scene of an engagement between the Prussian troops and Baden insurgents.

BRUCK, the name of two towns of Austria—

(1.) Bruck on the Mur, the chief town of a circle in the province of Steyermark, situated at the junction of the rivers Mur and Mürz, with a station on the railway from Vienna to Trieste, 25 miles N.W. of Gratz. It contains about 2900 inhabitants, and has a considerable transit trade. The principal building is the palace of the ancient princes of Bruck, which dates from the 14th century.

2. Bruck on the Leytha, the chief town of a circle in Lower Austria, with the castle of the counts of Harrach. It lies on the Vienna and Buda railway, 20 miles S.E. of Vienna. Population, 4203.

BRÜCKENAU, a town and fashionable watering-place of Bavaria, in the circle of Lower Franconia, on the Sinn, 16 miles N.W. of Kissingen. The mineral springs, which are five in number, situated in the pleasant valley of the Sinn, 2 miles from the town, were a favourite resort of Louis I. of Bavaria. Population in 1871, 2825.

BRUCKER, James, theologian, historian, philologer, and biographer, was born at Augsburg on the 22d of January 1696. His father, who was a respectable burgher, destined him for the church; and his own inclinations according with his father's wishes, he was sent at the usual age to pursue his studies in the university of Jena. Here he took the degree of master of arts in 1718; and in the following year he published his *Tentamen Introductionis in Historiam Doctrinæ de Ideis*, in 4to,—a work which he afterwards amplified and completed, and republished under the title of *Historia Philosophica Doctrinæ de Ideis*, at Augsburg in 1723. He returned to his native city in 1720; but here his merit having attracted envy rather than recompense, he was induced to accept of the office of parish minister of Kaufbevern in 1723. In the same year he published a memoir *De Vita et Scriptis Cl. Etringeri*, Augs. 8vo. His reputation having been at length established by these learned works, in 1731 he was elected a member of the Academy of Sciences at Berlin; and soon afterwards he was invited to Augsburg to fill the honourable situation of pastor and senior minister of the church of St Ulric. He published in the same year three dissertations relating to the history of philosophy, under the title of *Otium Vindelicum sive Meletematum Historico-philosophicorum Triga*, Augsburg, 1731, 8vo. Besides several smaller dissertations on biography and literary history, printed at different times, and which he afterwards collected in his *Miscellanea*, he published at Ulm, in 1737, *Neue Zusätze verschiedener Vermehrungen, &c., zu den kurtzen Fragen aus der philosophischen Historie*, 7 vols. 12mo. This work being a history of philosophy in question and answer, contains many details, especially in the department of literary history, which he has chosen to omit in his greater work on the same subject. He was forced by the booksellers, in opposition to his own opinion, to adopt the erotematic method, which at that time had been rendered popular by the writings of Hubner and Rambach.

In 1741, at Leipsic, appeared the first volume of his great work, *Historia Critica Philosophiæ, a mundi incunabulis ad nostrum usque ætatem deducta*. Four other ponderous quartos, completing the first edition of this elaborate history, followed in 1744. Such was the success of this publication, that the first impression, consisting of four thousand copies, was exhausted in twenty-three years, when a new and more perfect edition, the consummation of the labours of half a century devoted to the history of philosophy, was in 1767 given to the world in six volumes quarto. The sixth volume, consisting entirely of supplement and corrections, is applicable to the first as well as to the second edition. Of the merits of this work we shall speak in the sequel.

His attention, however, was not wholly occupied by this stupendous undertaking. The following books would of themselves have been sufficient to exhaust the industry of any ordinary author:—*Pinacotheca Scriptorum nostra ætate literis illustrium*, &c., Augsburg, 1741–55, folio, in five decades. *Ehrentempel der Deutschen Gelehrsamkeit in welchem die Bildnisse gelehrter Männer unter den Deutschen aus dem XV., XVI., und XVII. Jahrhundert aufgestellet, und ihre Geschichte, &c., entworfen sind*, Augsburg, 1747–49, 4to, five decads. *Institutiones Historiæ Philosophicæ*, Leipsic, 1747, 8vo, second edition, *ibid*, 1756; a third has been published since Brucker's death, with a continuation by Professor Born of Leipsic, in 1790. *Miscellanea Historiæ Philosophicæ Literariæ Criticæ olim sparsim edita, nunc uno fasce collecta*, Augsburg, 1748, 8vo. *Erste Anfangsgrunde der philosophischen Geschichte, als ein Auszug seiner grossern Werke, zweyte Ausgabe*, Ulm, 1751, 8vo. He likewise superintended and corrected an edition of Luther's translation of the Old and New Testment, with a Commentary extracted from the writings of the English theologians, Leipsic, 1758–70, folio, six parts. His death ensued before the completion of this work, which has since been accomplished by Teller. He died at Augsburg in 1770; and he may be added to the catalogue of Huetius, to prove that literary labour is not incompatible with sound health and longevity. (See Saxii *Onomasticon; Biographie Universelle;* Gesner's *Isagoge.*)

It is only by his writings on the history of philosophy that Brucker is now known in the literature of Europe. In this study his great work forms an important era, and even at the present day it is the most extensive and elaborate upon the subject. It is, however, a work of which the defects are great, and its errors have been important in their consequences, in proportion to the authority it has acquired. We shall, therefore, hazard a few general observations on the defects which chiefly detract from the perfection and utility of the *Critical History of Philosophy.*

If Brucker had carried into this study a penetration equal to his diligence, and had his general comprehension of the scope and

nature of the subject corresponded with the elaborate minuteness of his details, he would have left us a work which might have had some pretensions to be considered as a rational history of human opinion. He lived, however, at a period when these different qualities were only beginning to be conjoined, and when as yet the history of philosophy had been written merely as a chronicle of the passing theories of individuals and sects. To give to the science of history a regular and connected form, and to arrange the narrative of successive events, and still more of successive opinions, according to the relation they bear to principles of established influence, was an attempt of which few in that age had any conception, and of which Brucker certainly had none. In civil history it was then believed that the historian had fulfilled all the duties of his office if he strung together the events which were known or believed to have occurred, in good language, and garnished them occasionally by a few general reflections on the absolute motives of human action. A very different notion is now held of the functions of the historian. He who at present attempts to write the history of any country must reflect, before he begins, what were the chief occurrences in that history, and what were the revolutions which the manners and constitution of that particular nation have undergone. He must bear with him, from the commencement to the conclusion of his labours, a constant impression that every occurrence should be more or less considered, not only as it took place, and as it bore an influence on contemporary affairs, but as it may have remotely contributed to the events, and the opinions, and the character of succeeding times. But if this be true in regard to the histories of particular nations, it is evident that, by how much the traces of opinions are more light and evanescent than those of events, by how much the speculations of philosophers whose writings have either perished or come down to us mutilated and obscure are more difficult to be appreciated in their causes, and connections, and consequences, than the actions of warriors and statesmen,—by so much the more is it necessary in philosophical than in civil history to combine reasoning with erudition, and to substitute the researches of the philosopher for the details of the chronicler. History and philosophy are two different things; and he who would write the history of philosophy must excel in both. Bacon had long ago required this union, and had pointed out the manner in which the historian of literature should endeavour to establish those principles of connection which constitute the soul and charm of such a history; how, by detecting the union of effects and causes, he might be enabled to determine the circumstances favourable or adverse to the sciences; and how, in short, by a species of enchantment, he might evoke the literary genius of each different age. The fulfilment of this plan was, however, far beyond the capacity of Brucker, and was an undertaking of which he had even no conception. Better qualified by nature and education for amassing than arranging materials, he devoted his principal attention to a confused compilation of facts, leaving to others their application, the discovery of their mutual connections, and the formation of the scattered fragments into a whole.

The merit of his great work consists entirely in the ample collection of materials. The reader who would extract any rational view of the progress of opinion must peruse it with a perpetual commentary of his own thoughts. He will find no assistance from his author in forming any general views, or in tracing the mutual dependencies of the different parts of the subject. Brucker has discovered the fountains of history, but he has made us drink of them without purifying the draught. Even in this respect his merit has been greatly overrated. Vast as is the body of materials which he has collected, we are always missing those very things which we might reasonably have expected would have been the first objects of a rational inquirer, and we are continually disappointed of the information we are most anxious to acquire. The idle and slavish attention which he has bestowed on previous compilers has frequently diverted him from the study of the original authors themselves. Quoting the passages of the ancients from others, or trusting perhaps to the reference of an index, he has frequently overlooked those very testimonies which could have given us the most authentic knowledge of the opinions or characters of ages and individuals. He has often presented the authorities he has adduced, mutilated or misapplied; and this either from not having sufficiently studied these passages in their general connection with the system they illustrate, or from having been unable to withdraw them from the obscurity in which they were involved. He has shown no critical sagacity in distinguishing the spurious from the authentic, or in balancing the comparative weight of his authorities. He has frequently transcribed where he ought to have explained the words of the original authors; and, without taking into account the different value of the same term in different nations and ages, he has left us to apply a doubtful or erroneous meaning to words which might have been easily rendered by other expressions, and to suppose a distinction in the sense where there only existed a difference in the language. The glaring errors, even, which occasionally occur in his expositions of the Grecian philosophy, while they are inconsistent with any critical knowledge of the tongue, would make us suspect that he was in the habit of relying on the treacherous aid of translations. In short, if we knew nothing more of the ancient philosophers than what we acquire from Brucker, we should be often obliged to attribute to them opinions so obscure, or so absurd, that we must either believe ourselves wrong in the interpretation, or be unable to comprehend the cause of all the admiration and reverence they have received.

He has discovered little skill in his analysis of the different systems of philosophy; and the confusion of what is essential and principal with what is accidental and subordinate clearly evinces that these abridgments were thrown together while acquiring, in detail, a knowledge expressly for the purpose, instead of being the consummation of a long and familiar meditation on the subjects in all their modifications and dependencies. He has dwelt with the most irksome minuteness on every unimportant and doubtful circumstance in the lives of the philosophers; but he has too often overlooked the particular and general causes that produced an influence on the destinies of their philosophy. The aphoristic method which he has adopted prevents him from following a consecutive argument throughout its various windings. The most convincing reasoning in his hands loses much of its demonstration and beauty; and every ingenious paradox comes forth from his alembic a mere *caput mortuum*,—a residue from which every finer principle has been expelled. Where the genius of the philosopher is discovered more in the exposition and defence than in the original selection and intrinsic stability of his tenets, Brucker has not found the art of doing justice both to the philosopher and to his opinions, or of conveying to the reader any conception of the general value of the original. This last defect, it must, however, be acknowledged, is more or less inseparable from every abstract of opinions, where it is always necessary to separate in some degree what is essential to the subject from what is peculiar to the man. He has relieved the sterility of his analysis by none of the elegancies of which the subject was susceptible. Without any pretension to purity, his diction is defective even in precision; and his sentences, at all times void of harmony and grace, are abrupt, and often intricate in their structure. (W. H.)

BRUGES (in Flemish BRUGGE), a city of Belgium, the capital of West Flanders, is situated in the midst of a fertile plain, intersected by the canals of Ghent, Ostend, and Sluys, in 51° 12′ N. lat. and 3° 13′ E. long. It is, in a direct line, about 7 miles from the sea, 12 miles E. of Ostend, 24 N.W. of Ghent, and 60 miles in the same direction from Brussels. The history of Bruges dates from about the 3d century of the Christian era. In the 7th it had emerged into importance; and its corporation of weavers, which afterwards in its best days numbered 50,000 men, was already highly renowned in the time of Charlemagne. In the 9th century Bruges became subject to the counts of Flanders, who resided there, and made the city one of the most populous and wealthy in Europe by the great advantages and immunities which they offered to merchants and manufacturers. The inhabitants guarded with the most jealous care the privileges which they sometimes received and sometimes exacted from their rulers, and not unfrequently rose in arms for their defence. Though Bruges, and Ghent, and other Flemish towns owned a common lord, their interests were never identified, and they seldom let an opportunity pass of doing each other as much injury as possible. In the middle of the 14th century Bruges passed by marriage into the hands of the dukes of Burgundy, under whom it reached the highest point of its prosperity. The magnificence of the Flemish court was such that no European monarch could equal or approach it. When the wife of Philip the Fair of France visited Bruges at the beginning of the 14th century, "There are hundreds here," she exclaimed, "who have more the air of queens than myself;" and to such an extent was this extravagance ultimately carried that Charles V. was obliged, in the 16th century, to repress it by severe sumptuary laws. In 1430 Philip the Good, duke of Burgundy, instituted at Bruges the chivalric order of the Golden Fleece, a compliment to the town, no small portion of whose prosperity arose from its woollen trade. In the 14th and 15th centuries, Bruges was the chief emporium of the cities of the Hanseatic league; and merchants from every quarter of the world found there a ready market for their

goods. The argosies of Venice and Genoa came laden with the produce of the East; ships of every nation took in and discharged their cargoes at the quays; the warehouses were filled with bales of wool from England, and with silk from Persia. Not the least famous of the manufactures was that of tapestry, in which the people of Bruges acquired great skill a century before the looms of Beauvais or the Gobelins were set up. The prosperity of Bruges was undiminished till it passed under the dominion of the house of Hapsburg. For a violation of some of their prerogatives, the inhabitants imprisoned the Archduke Maximilian in 1488, and a terrible vengeance was inflicted upon the town for this outrage. Its trade was transferred to Antwerp, and its ruin was ultimately completed by the religious persecutions of the bloody duke of Alva at the end of the 16th century. Such of the inhabitants as escaped with their lives fled to England and introduced into that country many of the arts and manufactures which they and their forefathers had cultivated with success for many generations. In more modern times the town has frequently suffered from the effects of war. In 1704 it was besieged by the Dutch, and in 1708 and 1745 it was captured by the French. The contrast between the Bruges of the 15th century and the Bruges of recent times is as striking as it is painful. As Wordsworth says—

> "In Bruges town is many a street
> Whence busy life hath fled,
> Where, without hurry, noiseless feet
> The grass-grown pavement tread."

The great circumference of the city, its numerous squares and streets, and the number and magnificence of its public buildings, all attest its former importance; while the comparative absence of commercial activity, and the general air of desolation, bear witness to its present insignificance. Its trade has, however, considerably revived during the present century, and its great advantages in canal and railway communication, its spacious docks and excellent quays, and the great fertility of the surrounding country, are once more restoring it to its high place among cities. Of the public buildings of Bruges the most remarkable are the Church of Nôtre Dame, containing a sculpture of the Virgin and Child, said to be by Michel Angelo, effigies in copper of Charles the Bold and Mary of Burgundy, who are buried in the church; the cathedral of St Sauveur, built of brick, but internally the handsomest church in Bruges, with some fine pictures by Hemling (or, more correctly, Memling,—see *Athenæum*, No. 2513) and Peter Porbus; the hospital of St John, a charitable institution, where sick persons are attended by the sisters of charity; the exchange, which is the oldest in Europe; the courthouse, a fine building, partly on the site of the old palace of the counts of Flanders; and the Hôtel de Ville, a small but handsome edifice, dating from 1377 and restored in the present century, in the niches of which there were formerly statues of the old counts of Flanders, which were destroyed by the French revolutionists in 1792. The belfry-tower in the great square, of which Longfellow sings so finely, is the most beautiful structure of the kind in Europe, and its chimes are the best in Belgium. It was erected at the end of the 14th century, and is still used for communicating the alarm of fire by a flag or a light to all parts of the city. In this same square is a house in which Charles II. resided during his exile from England. Among the conventual establishments the most important are the Béguinage and the English nunnery. The town is likewise well provided with the means of education. There is a medical school, to which is attached a museum of natural history and a botanical garden. For the higher departments of school training there is an excellent athenæum, annually subsidized by Government, besides a theological seminary, a school of navigation, and an institution for the deaf and dumb and blind. The academy of painting is in a very flourishing condition, and offers many advantages to the student, as instruction is given gratis in drawing and architecture. The public library in the town-hall contains upwards of 15,000 volumes. The charitable institutions of Bruges are both numerous and well organized. They are all the more necessary, that the number of persons in the city requiring support is unusually great. In the poorhouse alone there is accommodation for nearly 600 individuals, and it is almost always completely filled. The most important manufacture in Bruges is that of lace. The other manufactures consist of linens, woollen and cotton goods, soap, leather, tobacco, starch, pottery, and bells. There are also some small breweries and distilleries, and dyeing and bleaching establishments; and ship-building is also carried on. The exports from Bruges comprise the products of the rich agricultural district that surrounds the town; the imports include metals, dyewoods, wines, fruits, oil, cotton, and wool. Despite the number of canals, the inhabitants of Bruges are very ill supplied with water for domestic purposes; every house is accordingly provided with a tank or butt to receive rain-water. The quantity collected in the public tanks is distributed through the city in pipes. Of the canals the largest is that to Ostend, wide and deep enough to allow vessels of 500 tons to pass up from the sea. The ramifications of these canals intersect the city in all directions, and are crossed by upwards of fifty bridges, whence the name of the town is derived. Population in 1838, 44,374; in 1846, 49,308; in 1851, 50,698; in 1866, 49,819.

See Weale's *Bruges et ses environs*, 1865; Gilliodts van Severen, *L'Inventaire des archives de la ville de Bruges*, 3 vols.

BRUMATH, or BRUMPT, a town of Lower Alsace, in the circle of Strasburg, on the River Zorn. It has a castle and mineral wells, and occupies the site of the ancient Brucomagus. Population in 1871, 5619.

BRUNCK, RICHARD FRANÇOIS PHILIPPE (1729–1803), a French scholar, was born at Strasburg, 20th December 1729. He was educated at the Jesuits' college at Paris, but having early entered the public service, he soon forgot his Latin and Greek. At the age of thirty he returned to his native town and resumed his studies, paying special attention to Greek. The nature of the office which he held put considerable sums of money at his disposal, which he expended in publishing editions of the Greek classics. The first work which he edited was the *Anthologia Græca*, in which his innovations on the established mode of criticism startled European scholars; for wherever it seemed to him that an obscure or difficult passage might be made intelligible and easy by a change of text, he did not scruple to make the necessary alterations, whether the new reading were supported by manuscript authority or not. With the assistance of Schweighäuser, then an unknown youth, he next brought out editions of the Greek dramatists, characterized by the same peculiarities as the *Anthologia*, and ultimately the *Gnomici Poetæ Græci*. In 1781 he published an edition of *Virgil*, for which he was pensioned by the French king. At the outbreak of the French Revolution, in which he took an active part, he lost his pension, and was reduced to such extremities that he was obliged to sell a portion of his library. In 1802 his pension was restored to him, but too late to prevent the sale of the remainder of his books. He had brought out an edition of *Plautus* in 1788, and was in the act of republishing it when he died, June 12, 1803.

BRUNDUSIUM, or BRUNDISIUM. See BRINDISI.

BRUNEL, ISAMBARD KINGDOM (1806–1859), one of the most distinguished civil engineers of the age, was born at Portsmouth, April 9, 1806. He was the only son of Sir

Marc Isambard Brunel, from whom he inherited some rare intellectual gifts, and to whom he owed his first education. From his earliest years he took an eager and intelligent interest in all the plans and undertakings of his father, who had then just completed the construction of the remarkable block machinery at Portsmouth. He displayed in childhood singular powers of mental calculation, great skill and rapidity as a draughtsman, and a true feeling for art. After attending some private schools, he was sent at the age of fourteen to Paris, to study mathematics, and to recover his knowledge of French. From November 1820 to August 1822 he studied at the Collége Henri Quatre; and in holiday intervals he used to visit the engineering works going on in Paris, and send his father drawings and descriptions of them. In 1823 he entered his father's office as assistant-engineer, just at the time when the project of the Thames Tunnel began to occupy the attention of Sir Isambard; and from 1825, when the work was begun, till 1828, when it was stopped by an irruption of the river, he displayed a singular energy, inventiveness, and power of application in that struggle of science against natural obstacles on a vast scale. He had even then the power, which distinguished him in later years, of doing almost without sleep for many nights when work was pressing. During the later part of the contest which ended by a second irruption in January 1828, he was both nominal and actual resident engineer of the Thames Tunnel. Left for nearly two years without regular professional occupation, Brunel employed himself in scientific researches, enjoying intercourse with Babbage, Faraday, and other friends. In November 1829 he sent in designs and plans for the projected Suspension Bridge over the Avon at Clifton. In consequence of objections raised by Telford, the referee of the bridge committee, Brunel's plans were rejected. But on a second competition, early in 1831, he sent in a new design, and this was accepted. Brunel was appointed engineer to the trustees, and the works were begun in 1836. Delay had been caused by want of funds, and from the same cause the works were afterwards suspended for some years, and were not completed during Brunel's lifetime. In March 1833, Brunel, at the age of twenty-seven, attained one of the highest professional positions by his appointment as engineer of the newly-projected Great Western Railway. For several years his energies were taxed to the utmost by the conflict with obstructive landowners and short-sighted critics; but he showed himself equal to the occasion, not only as a professional man, but as a persuasive negotiator. For solidity of construction and for skill and beauty of design the Great Western Railway, though one of the first made in England, holds a very high place. Among the triumphs of the engineer are the Hanwell Viaduct, the Maidenhead Bridge, and the Box Tunnel, at the time the longest in the world; and, on extensions of the line, the great bridges at Chepstow and Saltash. The now notorious "battle of the gauges" took its rise from Brunel's introduction of the broad gauge on this line. In 1846 he resigned his office as engineer of the Great Western Railway. In 1844 he had recommended the adoption of the Atmospheric System on the South Devon Railway, but after a year's trial this system was abandoned. The last and greatest of Brunel's railway works was the Royal Albert Bridge of the Cornwall Railway, crossing the River Tamar at Saltash. This work, sanctioned by parliament in 1845, was constructed between 1853 and 1859. In addition to the arduous labours of railway engineering, Mr Brunel had taken a leading part in the systematic development of ocean steam navigation. As early as October 1835 he had suggested, to the amusement of the directory of the Great Western Railway, that they should "make it longer, and have a steamboat to go from Bristol to New York, and call it the Great Western." The project was taken up, and the "Great Western" steamship was designed by Brunel, and built at Bristol under his superintendence. It was much longer than any steamer of the day, and was the first steamship built to make regular voyages across the Atlantic. While the vessel was building a controversy was raised about the practicability of Brunel's scheme, Dr Lardner asserting dogmatically that the voyage could not be made, and backing his assertion with an array of figures. His view was widely accepted, but the work went on, and the voyage was accomplished in 1838. A greater work was at once undertaken, and the "Great Britain" was built. This was the first large iron steamship, the largest ship afloat at that time, and the first large ship in which the screw-propeller was used. She made her first voyage from Liverpool to New York in August and September 1845; but in the following year was carelessly run upon the rocks in Dundrum Bay on the coast of Ireland. After lying there nearly a year without material damage she was got off and was employed in the Australian trade. Brunel soon after began to meditate a vaster project still, the construction of a vessel large enough to carry all the coal required for a long voyage out, and if coal could not be had at the out port, then to carry enough also for the return voyage. It seemed to him, further, that a great increase of size would give many advantages for navigation. During his connection as engineer with the Australian Mail Company he worked out into a practical shape his conception of a "great ship;" and in 1852 his scheme was laid before the Directors of the Eastern Steam Navigation Company. It was adopted, the projector was appointed their engineer, and after much time occupied about contracts and specifications, the work was begun in December 1853. Immense difficulties in the progress of construction caused delays from time to time. The operations of launching was several times attempted in vain; but at length the gigantic vessel, the now familiar "Great Eastern," was got afloat (31st January 1858). Much remained to be done to complete the ship; and her engineer, overworked and worn out with the worry of the launching processes, broke down and did not live to see her sail on her first voyage. In addition to the great works already described, Brunel was employed in the construction of many docks and piers. The first of these was the Monkwearmouth Docks, for which he made the designs in 1831. The construction, after a new design, was begun in 1834. He was afterwards engaged in works of the same kind at Bristol, Plymouth, Briton Ferry, and Brentford, and on a pier at Milford Haven. He was a zealous promoter of the Great Exhibition of 1851, and was a member of the committee on the section of machinery and of the building committee. He paid much attention to the subject of improvement of large guns, and designed a floating gun-carriage for the attack on Cronstadt in the Russian war (1854); he also designed and superintended the construction of the hospital buildings at Renkioi, on the Dardanelles (1855). The genius, energy, and industry of Brunel in his profession were not more remarkable than the high moral tone which characterized his whole life, and the fascinating qualities which gave him immense personal influence, and made him the delight of the social circle. With single-hearted truthfulness he devoted himself to his chosen work; he was singularly free from professional jealousy, and was always ready to commend and help others. With robust health, which he enjoyed through many years, he had the two invaluable qualities of good spirits and good temper. In his relations with his subordinates he was considerate and kindly, at the same time that he demanded faithful service according to a high standard. He cared nothing for popularity. He enjoyed

the beauties of a fine landscape, and was an enthusiastic lover of the fine arts. In the course of his busy life he several times went to Italy and Switzerland; and in 1847 he bought a small estate in Devonshire, to make his home there. The pressure of business, however, did not allow him to spend much of his time in the country. In 1830 Brunel was elected F.R.S., and he was afterwards a member of many other scientific societies. In 1857 the honorary degree of D.C.L. was conferred on him by the university of Oxford. In July 1836 he married; he left two sons and a daughter surviving him. For the sake of his health he spent the winter of 1858-59 in Egypt, returning to England in May. He was on board his "great ship" on the 5th September 1859, and the same day was attacked with paralysis. The ship sailed on her first voyage on the 7th, and her great projector passed away on the 15th of the month. His remains were interred in Kensal Green Cemetery. In 1870 appeared *The Life of I. K. Brunel, C.E.*, by his son Isambard Brunel, of Lincoln's Inn, chancellor of the diocese of Ely. (W. L. R. C.)

BRUNEL, Sir Marc Isambard (1769-1849), was born at Haqueville, in Normandy. His family had for several centuries held a respectable station in the province, living as farmers and small landowners on the estate on which he was born, and numbering among its members Nicholas Poussin. He was educated at the seminary of St Nicaise at Rouen, with the intention of his entering holy orders; but his predilection for the physical sciences was so strong, and his genius for mathematics and mechanics so decided, that, on the advice of the superior of the establishment, he was removed to follow a more congenial career. His father then destined him for the naval service, which he entered on the appointment of the Marshal de Castries, the minister of marine, and made several voyages to the West Indies. In this position, although only in his seventeenth year, his mechanical talents developed themselves actively on many occasions, and he surprised his captain by the production of a sextant of his manufacture with which he took his observations. On his return to France in 1792, he found the Revolution at its height, and like all who entertained royalist principles, he was compelled to seek safety in emigration. He effected his flight with considerable difficulty, and found refuge in the United States of America, where, driven by necessity to the exercise of his talents as a means of support, he followed the bent of his inclination and became a civil engineer and architect. His first engagement was on the survey of a tract of land near Lake Erie; he then became engaged in cutting canals, and was employed to erect an arsenal and cannon foundry at New York, where he applied several new and ingenious machines. His highly ornamental design for the House of Assembly at Washington was rejected, as being inconsistent with the simplicity of a republic; he was, however, engaged to design and superintend the construction of Bowery Theatre, New York, since destroyed by fire, the roof of which was peculiar and original.

The idea of substituting machinery for manual labour in the making of ships' blocks had long occupied his mind; and, in 1799, having matured his plans, he determined to visit England. Earl St Vincent was at that time at the head of the Admiralty, and after the usual delays and difficulties, which were ultimately overcome chiefly through the powerful influence of his steady friend and patron Earl Spencer, aided by the recommendation of Brigadier-General Sir Samuel Bentham, who at once perceived and appreciated the merit of the machines and the talent of the inventor, the system was adopted, and the machinery erected. The construction of the machines was entrusted to Mr Henry Maudslay, whom Brunel had selected with true discrimination, and by whom he was ably assisted. The beautiful simplicity of these machines, their perfect adaptation to their various purposes, and, notwithstanding the recent advances in mechanics, their continuing for nearly half a century in active work, without any improvements having ever been suggested, must rank them as among the most complete and ingenious pieces of mechanism ever invented.

The block machinery was completed in 1806, and it was estimated that the economy produced by it in the first year was about £24,000, two-thirds of which sum was awarded to the ingenious inventor, who was soon after engaged by the Government to erect extensive saw-mills, on improved principles, at Chatham and Woolwich. He there suggested modifications of the systems of stacking and seasoning timber, which were afterwards carried into effect. Some time previously, he had invented the ingenious little machine for winding cotton-thread into balls, which, simple as it may at first sight appear, has exercised great influence on the extension of the cotton trade.

He found time also to invent an instrument for combining the use of several pens, so as to produce simultaneously a number of copies of a manuscript; a simple and portable copying-machine; and a contrivance for making the small boxes used by druggists, which had been previously imported in large quantities from Holland. A nail-making machine also occupied his attention; and he discovered the system of giving the efflorescent appearance to tinfoil, by which it was fitted for ornamental purposes. Among other more important improvements may be mentioned that of cutting veneers by circular saws of large diameter, to which is mainly due the present extensive application of veneers of wood to ornamental furniture. About the year 1812 he had devised a scheme for making shoes by machinery; and, under the countenance of the duke of York, the shoes so manufactured, in consequence of their strength, cheapness, and durability, were introduced for the use of the army; but at the peace in 1815, manual labour becoming cheaper, and the demand for military equipments having ceased, the machines were laid aside.

Steam navigation also attracted his attention, and he became deeply interested in establishing the Ramsgate steam vessels, which were among the first that plied successfully on the River Thames; and on board of them it is believed that the double engines were first used. About this period, after much labour and perseverance, he induced the Admiralty to permit the application of steam for towing vessels to sea, the practicability of which he had strenuously urged. The experiments were tried chiefly at his own expense; a small sum in aid had been promised, but it was eventually withdrawn before the completion of the trials, the Admiralty considering the attempt "too chimerical to be seriously entertained." He introduced various improvements in the steam-engine, and for nearly ten years persevered in the attempt to use liquefied gases as the source of motive power, in which he was ably assisted by his son. The necessary experiments were most laborious, and needed all the persevering energy and resources of a mind determined not to be foiled; in spite, however, of his efforts, after a great sacrifice of time and money, the plan was abandoned.

The whole power of his mind, however, was for many years concentrated on one great object, the construction of the tunnel for communication from shore to shore beneath the bed of the River Thames. It is said that the original idea occurred to him, as applied to the Neva at St Petersburg, in order to avoid the inconvenience arising from the floating ice,—a plan which he offered to the Emperor Alexander, on the occasion of his visit to England in 1814. Undismayed by previous signal failures in the attempt

to construct a tunnel beneath the Thames, Brunel, confident in his own powers, persevered, and in 1824, under the auspices of the duke of Wellington, who always entertained a favourable view of the practicability of the scheme, a company was formed for its execution; and after numerous accidents and suspensions of the works, this great and novel undertaking was successfully accomplished, and the tunnel opened to the public in the year 1843.

In the prosecution of the work he received great assistance from his son, Isambard Kingdom Brunel, and in a scientific point of view the construction of the tunnel will be regarded as displaying, at the same time, the highest professional ability, an amount of energy and skill rarely exceeded, and a fertility of invention and resources, under what were deemed insurmountable difficulties, which will secure to the memory of Sir Isambard Brunel a high position among the engineers of England.

He received the order of the Légion d'Honneur in 1829, and the honour of knighthood in 1841. He was a corresponding member of the French Institute, and a fellow of the Royal Society. He joined the Institution of Civil Engineers in the year 1823, and constantly attended the meetings, took part in the discussions, and promoted the society's interests by every means in his power.

He was unaffected and simple in his habits, and possessed indomitable courage, perseverance, and industry; whilst his benevolence constantly prompted him to kindly and considerate actions. His labours had so seriously impaired his health, that for some years after the completion of the tunnel he was unable to mix in active life. He died on the 12th of December 1849, in his 81st year. (See Richard Beamish, *Memoirs of Sir Marc Isambard Brunel*, 1862.)

BRUNELLESCHI, Filippo, (1377–1446), one of the greatest Italian architects, the reviver in Italy of the Roman or Classic style, was born at Florence in 1377. His father, a notary, had destined him for his own profession, but observing the boy's talent for all sorts of mechanism, placed him in the guild of goldsmiths. Filippo quickly became a skilled workman, and, eagerly desirous to excel, perfected himself in the knowledge of sculpture, perspective, and geometry,—whatever, in short, was useful for the architectural art, to which he found himself attracted. He designed some portions of houses in Florence, and in 1401 he was one of the competitors for the design of the gates of the baptistery of San Giovanni. He was unsuccessful, though his work obtained praise, and he soon afterwards set out for Rome. He studied hard, and resolved to do what he could to revive the older classical style, which had died out in Italy. In 1407 he returned to Florence, just at the time when it was resolved to attempt the completion of the cathedral church of Santa Maria del Fiore. Brunelleschi's plan for effecting this by a cupola was approved, but it was not till 1419, and after innumerable disputes, that the work was finally entrusted to him. At first he was hampered by his colleague Ghiberti, of whom he skilfully got rid. He did not live to see the completion of his great work, and the lantern on the summit was put up not altogether in accordance with the instructions and plans left by him. The great cupola, one of the triumphs of architecture, exceeds in some measurements that of St Peter's at Rome, and has a more massive and striking appearance. Besides the masterpiece Brunelleschi executed numerous other works, among the most remarkable of which are the Pitti Palace at Florence, and the churches of San Lorenzo and Spirito Santo, and the still more elegant Capella dei Pazza. He died in 1446, and was buried in the great church of Santa Maria. See Architecture, vol. ii. p. 436.

BRUNET, Jacques Charles, the eminent bibliographer, was born at Paris in 1780, and died in 1867. He was the son of a bookseller, and at an early age began the study which occupied the whole of his after life. In 1802 he printed a supplement to the *Dictionnaire Bibliographique* of Duclos and Cailleau, and in 1810 there appeared the first edition of his *chef-d'œuvre*, the *Manuel du Libraire*. With the exception of a few pamphlets and minor dissertations, Brunet published nothing beyond successive editions of his great bibliographical dictionary, which had come to be recognized as the first book of its class in European literature. The last (fifth) edition in six volumes was completed in 1865.

BRUNI, Leonardo (1369–1444), author of the *History of Florence*, was an eminent scholar of the 15th century. He was born at Arezzo, and is generally known as L. Aretino. He was secretary to the papal chancery under Innocent VII. and John XXII. From 1427 to his death in 1444 he was chancellor to the republic of Florence. He was buried at the expense of the state in Sta. Croce, where his laurelled statue is still to be seen. His *History of Florence* comes down to 1404.

BRÜNN, the capital of the Austrian margraviate of Moravia, is situated for the most part between two hills at the confluence of the Schwarzawa and the Zwittawa, 69 miles N. of Vienna and 115 W.S.W. of Prague, with both of which it is connected by railway. Lat. 49° 11′ 39″ N., long. 16° 39′ 35″ E. On one of the hills known as the Spielberg stands the castle of the same name, which has long been used as a prison, and is famous for its connection with the patriotic Silvio Pellico, who was confined within its walls for about eight years. The old town, which is comparatively small, still retains some of its fortifications, but most of them have given place to promenades. Its streets are narrow and crooked but well-paved, and it contains many of the most important buildings in the city. Extensive suburbs have grown up around it, and since 1849 form portions of the same commune. There are fine public gardens and a large park known as the Augarten, presented to the town by the Emperor Joseph II. The Rathhaus, which dates from 1511, has a fine Gothic portal, and contains several interesting antiquities. The ecclesiastical buildings comprise the cathedral of St Peter's, situated on the lower hill; the fine Gothic church of St James, built in the 15th century, with its iron tower added in 1845, and a remarkable collection of early typography; the church of the Augustine friars, dating from the 14th century; that of the Minorites with its frescoes, its holy stair, and its Loretto-house; the bishop's palace; a splendid Jewish synagogue; and several monastic establishments. As the capital of the province Brünn is the seat of the chief legal and military courts, and thus possesses various official edifices, the old Jesuit convent having been turned into barracks. It is also the seat of a Roman Catholic bishop and of a Protestant consistory. Its educational and benevolent institutions comprise a theological seminary, a gymnasium, several academies and schools, an agricultural society, a botanic garden, an infirmary, an orphanage, a blind asylum, a deaf-mute institution, a lunatic asylum, and several hospitals, of which the most important is the great hospital of St Anna. The national museum for Moravia and Silesia, though comparatively poor, must also be mentioned. Brünn is one of the chief seats of the woollen manufacture in the Austrian dominions, and the centre of a large miscellaneous trade. Considerable quantities of silk and cotton goods are manufactured, as also leather, paper, tobacco, oil, and sugar. There are also steam-flour-mills, engineering works, and breweries. There is a remarkable viaduct in the immediate neighbourhood of the town. Brünn probably dates from the 9th century. In the 11th it was bestowed by Duke Wratislas II. on his son Otto. Brünn is a place of great

strength, and held out successfully against sieges—in 1428 by the Hussites, in 1467 by King George of Bohemia, in 1645 by the Swedish general Torstenson, and in 1742 by the Prussians. In 1805 it was the headquarters of Napoleon before the battle of Austerlitz. Its population in 1869 was 73,771.

BRUNO, St, the founder of the Carthusian order of monks, was born at Cologne about the year 1030. He was educated at Cologne, and afterwards at Rheims, where he was appointed to superintend the studies in all the chief schools of the diocese. Many of his pupils afterwards became distinguished, and in the number was Pope Urban II. In 1084, after some disputes with Manasses, the archbishop of Rheims, he retired with six companions into the desert of Chartreuse, where he built an oratory, with cells at a little distance from each other. Six years afterwards he went to Rome, where Urban II. pressed him to accept the archbishopric of Reggio. He declined the honour, and withdrew into the solitudes of Calabra, where he died October 6, 1101. He wrote treatises on the Psalms and on some of the Epistles, but none of his works are extant. His canonization took place in 1514. (See Mrs Jameson's *Legends of the Monastic Orders*, 124–134; Butler's *Lives of the Saints*, vol. ii. 592.) This saint is not to be confounded with others of the same name,—the bishop and apostle of the Prussians (970–1008), and the great archbishop of Cologne (925–968).

BRUNO, Giordano, the most genial and interesting of the Italian philosophers of the Renaissance, was born at Nola about the year 1548. Little is known of the life of this knight-errant of philosophy; the very date of his birth rests in obscurity. What we do know is attractive enough to render it matter of regret that the materials should be so scanty. In his fifteenth year he entered the order of the Dominicans at Naples, and is said to have composed a treatise on the ark of Noah. Why he should have submitted to the bonds of a discipline palpably unsuited to his fiery and vehement spirit, we cannot tell. He soon found the restraints intolerable, and became an outcast from his church and a wanderer on the face of the earth. His opinions with regard to some of the Romish mysteries seem to have been too liberal to find toleration with so strict an order as that of St Dominic. He was accused of impiety, and after enduring persecution for some years, he fled from Rome about 1576, and wandered through various cities, reaching Geneva in 1577. The home of Calvinism was no resting-place for him, and he travelled on through Lyons, Toulouse, and Montpellier, arriving at Paris in 1579. Everywhere he bent his irrepressible energies to the exposition of the new thoughts which were beginning to effect a revolution in the thinking world. He had drunk deeply of the very spirit of the Renaissance, the determination to open his eyes and see for himself this noble universe, unclouded by the mists of authoritative philosophy and church tradition. The discoveries of Copernicus, which were unhinging men's minds and teaching them to look upon their little world in a new light, were eagerly accepted by him, and he used them as the lever by which to push aside the antiquated system that had come down from Aristotle, and which was loaded with the weight of that great thinker's name. For Aristotle, indeed, he had a perfect hatred. Like Bacon and Telesius he infinitely preferred the older Greek philosophers, who had looked at nature for themselves, and whose speculations had more of reality in them. He had read widely and deeply, and in his own writings we come across many expressions familiar to us in earlier systems. Yet his philosophy is no eclecticism. He owed something to Lucretius, something to the Stoic nature-pantheism, something to Anaxagoras, to Heraclitus, to the Pythagoreans, and to the Neo-platonists, who were partially known to him; above all, he had studied deeply and profoundly the great German thinker Nicolas of Cusa, who was indeed a speculative Copernicus. But his own system has a distinct unity and originality; it breathes throughout the fiery spirit of Bruno himself.

Bruno had been well received at Toulouse, where he had lectured on astronomy; even better fortune awaited him at Paris. He was offered a chair of philosophy, provided he would receive the Mass. He at once refused, but was permitted to deliver lectures. These seem to have been altogether devoted to expositions of a certain logical system which Bruno had taken up with great eagerness, the *Ars Magna* of Raymond Lully. With the exception of a comedy, *Il Candelajo*, all the works of this period are devoted to this logic. The most important of them is the treatise *De Umbris Idearum*. It has seemed to many a curious freak of Bruno's that he should have so eagerly adopted a view of thought like that of Lully, but in reality it is in strict accordance with the principles of his philosophy. Like the Arabian logicians, and some of the scholastics, who held that ideas existed in a threefold form,—*ante res*, *in rebus*, and *post res*,—he laid down the principle that the archetypal ideas existed metaphysically in the ultimate unity or intelligence, physically in the world of things, and logically in signs, symbols, or notions. These notions were the shadows of the ideas, and the *Ars Magna* furnished him with a general scheme, according to which their relations and correspondences should be exhibited. It supplied not only a *memoria technica*, but an *organon*, or method by which the genesis of all ideas from unity might be represented intelligibly and easily. It provided also a substitute for either the Aristotelian or the Ramist logic, which was an additional element in its favour.

In the train and under the protection of the French ambassador, Michel de Castelnau, Bruno passed over in 1583 to England, where he resided for about two years. He was much disgusted with the brutality of the English manners, which he paints in no flattering colours, and he found in Oxford pedantry and superstition as rampant as at Geneva. But he indulges in extravagant eulogies of Elizabeth, and he formed the acquaintance at London of Sir Philip Sidney, Fulke Greville, and other eminent Englishmen. At Oxford he was allowed to hold a disputation with some learned doctors on the rival merits of the Copernican and so-called Aristotelian systems of the universe, and, according to his own report, had an easy victory. The best of his works were written in the freedom of English social life. The *Cena de le Ceneri*, or Ash Wednesday conversation, devoted to an exposition of the Copernican theory, was printed in 1584. In the same year appeared his two great metaphysical works, *De la Causa, Principio, ed Uno*, and *De l'Infinito, Universo, e Mondi*; in the year following the *Eroici Furori* and *Cabala del Cavallo Pegaseo*. In 1584 also appeared the strange dialogue, *Spaccio della Bestia Trionfante*, or *Expulsion of the Triumphant Beast*, an allegory treating chiefly of moral philosophy, but giving at the same time the very essence and spirit of Bruno's philosophy. The gods are represented as resolving to banish from the heavens the constellations, which served to remind them of their evil deeds. In their places are put the moral virtues. The first of the three dialogues contains the substance of the allegory, which, under the disguise of an assault on heathen mythology, is a direct attack on all forms of anthropomorphic religion. But in a philosophical point of view the first part of the second dialogue is the most important. Among the moral virtues which take the place of the beasts are Truth, Prudence, Wisdom, Law, and Universal Judgment, and in the explanation of what these mean Bruno unfolds the very inner essence of his system. Truth is the unity and

substance which underlies all things; Prudence or providence is the regulating power of truth, and comprehends both liberty and necessity; Wisdom is providence itself in its supersensible aspect —in man it is reason which grasps the truth of things; Law results from wisdom, for no good law is irrational, and its sole end and aim is the good of mankind; Universal Judgment is the principle whereby men are judged according to their deeds, and not according to their belief in this or that catechism. Mingled with his allegorical philosophy are the most vehement attacks upon the established religion. The monks are stigmatized as pedants who would destroy the joy of life on earth, who are avaricious, dissolute, and the breeders of eternal dissensions and squabbles. The mysteries of faith are scoffed at. The Jewish records are put on a level with the Greek myths, and miracles are laughed at as magical tricks. Through all this runs the train of thought resulting naturally from Bruno's fundamental principles, and familiar in modern philosophy as Spinozism, the denial of particular providence, the doctrine of the uselessness of prayer, the identification in a sense of liberty and necessity, and the peculiar definition of good and evil. Altogether the *Spaccio*, as it is the most popular, is the most characteristic of Bruno's works.

In 1586 he returned to Paris with Castelnau, but was soon driven from his refuge, and we next find him at Marburg and Wittenberg, the headquarters of Lutheranism. There is a tradition that here or in England he embraced the Protestant faith; nothing in his writings would lead one to suppose so. Several works, chiefly logical, appeared during his stay at Wittenberg. In 1588 he went to Prague, then to Helmstadt. In 1591 he was at Frankfort, and published three important metaphysical works, *De Triplici Minimo et Mensura; De Monade, Numero, et Figura; De Immenso et Innumerabilibus*. He did not stay long at Prague, and we find him next at Zurich, whence he accepted an invitation to Venice. It was a rash step. The emissaries of the Inquisition were on his track; he was thrown into prison, and in 1593 was brought to Rome. Seven years were spent in confinement. On the 9th February 1600 he was excommunicated, and on the 17th was burned at the stake.

As has been said, for an estimation of Bruno's philosophy, the most important works are the two Italian dialogues and the three last-mentioned Latin treatises. It is not an easy matter to put his opinions into small compass, for the general form of exposition adopted by him, the dialogue, imposes a certain looseness on his own mode of thinking.

To Bruno as to all other great thinkers, the end of philosophy is the search for unity. Amid all the varying and contradictory phenomena of the universe there is something which gives coherence and intelligibility to them. Nor can this unity be something apart from the things; it must contain in itself the universe, which develops from it; it must be at once all and one. This unity is God, the universal substance,—the one and only principle, or *causa immanens*,—that which is in things and yet is distinct from them as the universal is distinct from the particular. He is the efficient and final cause of all, the beginning, middle, and end, eternal and infinite. By his action the world is produced, and his action is the law of his nature, his necessity is true freedom. He is living, active intelligence, the principle of motion and creation, realizing himself in the infinitely various forms of activity that constitute individual things. To the infinitely actual there is necessary the possible; that which determines involves somewhat in which its determinations can have existence. This other of God, which is in truth one with him, is matter. The universe, then, is a living cosmos, an infinitely animated system, whose end is the perfect realization of the variously graduated forms.

The unity which sunders itself into the multiplicity of things may be called the *monas monadum*, each thing being a *monos* or self-existent, living being, a universe in itself. Of these monads the number is infinite. The soul of man is a thinking monad, and stands mid-way between the divine intelligence and the world of external things. As a portion of the divine life, the soul is immortal. Its highest function is the contemplation of the divine unity, discoverable under the manifold of objects.

Such is a brief summary of the principal positions of Bruno's philosophy. It seems quite clear that in the earlier works, particularly the two Italian dialogues, he approached more nearly to the pantheistic view of things than in his later Latin treatises. The unity expounded at first is simply an *anima mundi*, a living universe, but not intelligent. There is a distinct development traceable towards the later and final form of his doctrine, in which the universe appears as the realization of the divine mind.

The Italian works of Bruno, formerly exceedingly rare, have been collected and published in two volumes, by A. Wagner, 1830. An edition of the Latin works was begun by Gfrörer in 1834, but has not been completed. The most complete monograph on him is that by C. Bartholmess, 2 vols. 1846–47; the most recent life is that by Domenico Berti, 1868. The best systematic account of his philosophy is that by Carriere, *Philosophische Weltanschauung der Reformationszeit*, 1847, pp. 411–494. The relations between his philosophy and that of Cusanus are treated in Clemens, *G. Bruno und Nicolaus von Cusa*, 1847. An English translation by Morehead (not, as is generally supposed, by Toland) of the *Spaccio* is dated 1713. It was probably printed before that time, and it is now excessively rare. Toland translated the preface to *De l'Infinito*; it is found in his *Posthumous Works*. There is a French translation of part of the *Spaccio*, *Le Ciel Reformé*, 1750. Lasson has translated *De la Causa* into German, 1872, with introduction and notes.

The earlier literature with regard to Bruno is copious; it will be found in Bayle, Buhle, and Tennemann. (R. AD.)

BRUNSWICK (German BRAUNSCHWEIG), a duchy and state of Northern Germany, forming part of the new German Empire, and included in the Prusso-German Zollverein. It consists of three larger and five smaller portions of territory lying mainly between 51° 38′ and 52° 28′ N. lat., and between 9° 20′ and 11° 30′ E. long. The principal part, containing the cities of Brunswick, Wolfenbüttel, and Helmstedt, is situated between Hanover and Prussia, to the S.E. of the former, and has its surface diversified by hill and plain. The part containing Holzminden and Gandersheim extends eastward from the Weser to Goslar, and is intersected by branches of the Hartz Mountains. The Blankenburg portion lies to the S.E. of the two former, between Prussia, Anhalt, and Hanover, and is traversed by the Hartz. Of the smaller portions some form *enclaves* in Hanover and others in Prussia.

Brunswick has an area of 1424 English square miles, and is divided into six circles, comprehending thirteen cities, and between four and five hundred smaller towns and villages. Besides the cities already mentioned the most important are Schöningen, Seesen, and Schöppenstedt. The population was in 1812, 209,527; in 1852, 271,208; in 1861, 281,708; and in 1871, 311,175. Of the last number 302,989 were Protestants, 7030 Roman Catholics, and 1171 Jews. The proportions in the political divisions were as follows:—

Circles.	Extent in square miles.	Inhabitants.		
		1861.	1867.	1871.
Brunswick	209	61,232	82,629	90,545
Wolfenbüttel	294	50,423	59,454	60,739
Helmstedt	304	41,155	52,023	53,705
Holzminden	221	41,290	42,129	41,551
Gandersheim	212	39,277	43,430	42,322
Blankenburg	184	19,855	22,925	22,523
	1424	253,232	302,792	311,715

Brunswick also possesses in Prussian Silesia the principality of Oels, which from 1647 to 1792 belonged to Würtemberg. A portion of the Hartz Mountains is common to Brunswick and Hanover, and is consequently known as the Communion-Hartz. Various minor arrangements have been made with Prussia for the more convenient organization of this district since the formation of the new German empire. The highest point of the mountains in the Brunswick territory is the Wormberg, 3230 feet in height. The principal rivers by which the duchy is watered are the Ocker, the Weser, the Aller, and the Leine. The lower parts of the country are generally fertile and well cultivated; the higher are mostly covered with forests of fir, oak, and beech. A very extensive improvement has been effected in the circle of Helmstedt by the draining of the *Drömling* swamp, and the rectification of the courses of the Aller and the Ohre. Of the whole duchy 32·7 per cent. is arable, 27·3 consists of meadow and pasture, and 31·8 is under wood. Agricultural and pastoral pursuits constitute the principal employment of the inhabitants; and the peasant class are usually well to do. The principal articles of cultivation are grain, potatoes, beetroot, flax, hops, and fruits. The growing of tobacco, which was formerly of great importance, is now very limited. In 1870 there were in the duchy 25,344 horses, 83,558 head of cattle, 386,757 sheep, 75,616 swine, 39,167 goats, 55,829 geese, and 8385 bee stocks. The mineral wealth of the country, which is chiefly derived from the Hartz Mountains, consists of copper, lead, iron, gold, silver, sulphur, coal, salt, and alum. In 1867 the total yield of coal was 219,400 tons, of iron ore 58,400, of pig-iron 143,000, of cast-iron 1584; the copper amounted to 383 tons; the lead to 710, and the vitriol to 1339. The manufactures, which are comparatively small, comprise (besides the preparation of the ores) spinning, weaving, and brewing. The principal iron-works are at Rübeland, Wieda, Delligsen, and Oker; and the chief centres of general industry are Brunswick and Schöningen. An active trade is carried on by means of the extensive railway communication with the rest of Germany.

The educational institutions comprise two ecclesiastical seminaries, an anatomical and surgical college, an architectural school at Holzminden, an agricultural school at Schöppenstedt, 5 gymnasiums, 25 burgher schools, and upwards of 400 village schools, besides several important establishments in the capital (see below). There is an extensive lunatic asylum at Königslutter, opened in 1865.

According to the constitution of 1832, which has been frequently modified, the Government is an hereditary monarchy, with a legislative assembly of representatives. These are chosen, by the law of 1851, twenty-one by those citizens who pay the largest amount of taxes, ten by the towns, three by the clergy, and a certain number by the communes. They hold office for six years, one-half going out triennially; and when they are not in session, they are represented by a standing committee of seven members. In the federal council the duchy has two votes, and it sends three deputies to the imperial diet. The ducal contingent, which still wears its famous black uniform, forms part of the 10th federal army corps. The state is the proprietor not only of a large proportion of the mines and forests in the duchy, but also of its railways. From these sources it derives a considerable part of its revenue, which in recent years has been augmented by the farming out of lotteries. By the budget for the period 1873–5, the annual receipts were fixed at 7,429,400 marks, or £371,470. The total debt, which had been mainly incurred for the formation of the railways, amounted to 65,400,000 marks, or £3,270,000.

The people of Brunswick are, with comparatively few exceptions, of Saxon race. The country people speak dialects of Low German, while High German is employed by the educated classes in the cities.

The more immediate ancestor of the house of Brunswick was Henry the Lion, who, in the 12th century, held the united duchies of Bavaria and Saxony; but having refused to aid the Emperor Frederick Barbarossa in his wars with the Pope, he was, by decree of the diet in 1180, deprived of both duchies, and only left the possession of his allodial domains of Brunswick and Lüneburg. His grandson, Otho, was invested in 1235 with these domains as a fief of the empire, and thus became the first duke of Brunswick. The two principalities which had been severed were united by Ernest the Confessor, but on his death in 1546, they were again divided between his two sons; the elder (or rather his son Augustus) receiving Brunswick-Wolfenbüttel, or Brunswick, and the younger Brunswick-Lüneburg, or Hanover. The ducal residence, which had before been at Wolfenbüttel, was in 1754 removed to Brunswick by Duke Charles. His successor, Duke Charles William Ferdinand, married Augusta, daughter of George III. of England He commanded the Prussian troops at Auerstädt in 1806, and soon after died of the wounds he had received in the battle. His possessions were immediately seized by Napoleon, and formed part of the kingdom of Westphalia till after the battle of Leipsic, when the duchy was restored to its rightful possessor, Frederick William, youngest son of the preceding duke. This prince fell at the head of his troops at Quatre Bras, and was succeeded by Charles Frederick, the elder of his two sons, who, being at that time a minor, was placed under the tutelage of George IV. of England, then prince-regent. The duke entered on the exercise of his authority in October 1823, but in consequence of a revolution in 1830 was obliged to abdicate in 1831 in favour of his brother William, the present duke. During the long reign of duke William many important changes have taken place in the internal organization of the duchy, and most of them have been in the direction of greater civil liberty. Of great moment was the establishment of a new criminal code in 1840; and publicity of parliamentary discussion, the freedom of the press, the introduction of jury-trials in criminal cases, and the legitimation of Christian-Jewish marriages were secured in 1849. In 1851 military service was recognized as binding on all, and the election of members of parliament was placed more directly in the hands of the people. In 1864 the *Stolgebühren*, or taxes paid to the established clergy on the occasion of a baptism, a marriage, or a burial, were made no longer leviable on Jews, Roman Catholics, or other dissenters. The introduction of the German commercial code was effected in 1864, and freedom of trade was introduced in the same year. Treaties of mutual inheritance exist between the houses of Hanover and Brunswick; and should the present duke, who is still unmarried, die without issue, the duchy will pass to the house of Hanover. The ex-duke, to whose sons the right would first have descended, died childless at Geneva in August 1873. He had spent his life in pitiable devotion to certain hobbies, the most remarkable of which was the collection of valuable diamonds. His various treasures were bequeathed to the city of Geneva, but the will is disputed by the present duke.

Brunswick, the capital of the above duchy, is situated on the Ocker, 37 miles E.S.E. of Hanover by rail, and 52 W.N.W. of Magdeburg, in 52° 16′ N. lat. and 10° 32′ E. long. In spite of the numerous alterations effected during the present century, the city is still of an antiquated appearance, and is for the most part contained within the limits of its old fortifications. These, which were dismantled in 1797, have given place to a regular circle of gardens and promenades, which rank among the finest in Germany.

The ducal palace is a handsome modern structure, erected since 1865, when the most of the previous building, which only dated from 1831, was destroyed by fire. The famous Quadriga of Rietschel, which perished at the same time, has been replaced by a copy by Howald. Among the ten or twelve churches in the town the most important are the cathedral of St Blaise, built by Henry the Lion in 1173; St Magnus's, which is the oldest, dating from 1031; St Andreas, with a spire 318 feet high; and St Catherine's, a building of the 13th century. The educational and charitable institutions of Brunswick are numerous and important. Of the former may be mentioned the *Collegium Carolinum*, founded in 1745, the great United Gymnasiums (which include the former commercial gymnasium, the Martineum, and the Catherineum), the Medico-Chirurgical College, and the Academy of Forestry; while among the latter are a deaf and dumb institution, a blind asylum, an orphanage, and various hospitals and infirmaries. There are also two public libraries, a museum, a theatre, and several scientific societies. A monument, 60 feet high, to Duke Frederick William, who was slain at Quatre Bras, gives its name to Monuments-Platz, and another to the S.E. of the town perpetuates the memory of Schill and his companions. The trade of Brunswick, formerly restricted by obsolete legislation, is gradually increasing. The principal articles of manufacture are coarse cloth and leather; and, to a smaller extent, gloves, papier-maché, and paper wares. The town has long been famous for a special kind of beer, called Mumme, from the name of the Brunswick brewer who invented it in 1492. In 1867 the population amounted to 50,369, inhabiting 3487 houses, and divided into 10,850 families. In 1871 it had increased to 57,883.

Brunswick is said to have been founded about 861 by Bruno, duke of Saxony, from whom it was named *Brunonis Vicus*. Afterwards enlarged and fortified by Henry the Lion, it became one of the most important cities of Northern Germany. For a long time its constitution was rather peculiar, as it consisted of five separate townlets, each with its own walls and gates, its own council and Rathhaus,—a condition of which traces are still evident. In the 13th century it ranked among the first cities of the Hanseatic league, but it never succeeded in obtaining imperial freedom. After this, however, it declined, in consequence of the many divisions of territory among the branches of the reigning house, the jealousy of the neighbouring states, the Thirty Years' War, and more recently the French occupation. In 1830 it was the scene of a violent revolution, which led to the removal of the reigning duke.

BRUNSWICK, a town of the United States of America, in Cumberland County, Maine, 27 miles N.N.E. of Portland, on the right bank of the Androscoggin River, which, with a fall of about 50 feet in half-a-mile, supplies a large amount of water-power. Numerous industrial establishments have been erected, the most important being a cotton factory, flour-mills, and bleach-works. The lumber-trade, which was formerly of great extent, has been in great measure replaced by the building and owning of ships. Besides possessing an excellent system of graduated schools, Brunswick is the seat of Bowdoin College, founded in 1802, and of the Maine Medical School, which dates from 1820. The river is crossed by two bridges, one of which unites the town with Topsham, and the other belongs to the Kennebec and Portland railway. Population in 1850, 4927; in 1870, 4687, or including the neighbouring village, 6136.

BRUNTON, MRS MARY (1778-1818), a novelist of the early part of the 19th century, was born on the 1st November 1778, in the island of Barra, Orkney. Her father, Colonel Balfour, was a man of importance in the island, and she received a very careful and excellent education. At the age of twenty she married the Rev. Mr Brunton, minister of Bolton in Haddingtonshire, who in 1803 received a call to a church in Edinburgh. In 1811 Mrs Brunton published anonymously her first novel, *Self-Control*. It at once became very popular; the first edition was sold off in a month, and a second and third q... followed. The book was especially recommended by high moral and religious tone; it was a novel with purpose. As a work of art, it cannot take a high p... the plot is extravagant and improbable, and the charact... have none of the charm of reality about them. The sto... is constructed after the model of *Clarissa*, and contains ... usual virtuous heroine and vicious hero, with an unu... number of abductions and mysteries. Her second n... *Discipline*, was published in 1814, and was received wi... equal favour. Mrs Brunton died on the 19th Decemb... 1818. An unfinished tale, *Emmeline*, was published afte... her death by her husband, with a notice of her life.

BRUSHES AND BROOMS are implements composed of a solid basis in which a tuft or tufts of hair or of vegetable or other fibres are secured. They are mentioned by various ancient writers, as Homer, Sophocles, and Euripides. Perhaps the earliest notice is the figurative "besom of destruction" (Isa. xiv. 23). Brushes are of two kinds, simple and compound. The former consist of but one tuft, as hair pencils and painters' tools. The latter have more than one tuft. Brushes with the tufts placed side by side on flat boards, as plasterers' brushes, are called stock-brushes. The single tuft brushes, or pencils for artists, are made of the hair of the camel, badger, goat, and other animals for the smaller kind, and pig's bristles for the larger. The hairs for pencils are carefully arranged so as to form a point in the centre, and, when tied together, are passed into the wide end of the quill or metal tube and drawn out at the other end to the extent required. The small ends of the quills having been previously moistened, in drying contract and bind the hair. A similar effect is produced with metal tubes by compression. Compound brushes are—first, set or pan-work; second, drawn-work. Of the former, an example is the common house-broom, into the stock of which holes are drilled of the size wanted. The necessary quantity of bristles, hair, or fibre, to fill each hole is collected together, struck on the working bench at the thick ends, dipped into molten cement chiefly composed of pitch, bound round with thread, dipped again, and then set into a hole of the stock with a peculiar twisting motion only to be acquired by practice. In drawn-brushes, of which those for shoes, teeth, nails, and clothes are examples, the holes are more neatly bored, and have smaller ones at the top communicating with the back of the brush, through which a bight or loop of wire passes from the back of the stock. Half the number of hairs or fibres needed for the tufts to fill the holes are passed into the bight of the wire, which is then pulled smartly so as to double the hairs and force them into the loop-hole as far as possible. With all brushes, when the holes have been properly filled, the ends of the fibres outside are cut with shears, either to an even length or such form as may be desired. The backs are then covered with veneer or other material to conceal the wire and other crudities of the work. A process called trepanning is adopted with some small brushes. The drawholes come out at some inconspicuous part of the stock, and the hairs or fibres having been properly secured, the holes are plugged up in order to conceal them as much as possible.

The bristles used in this manufacture are imported chiefly from Russia and Poland, and are sorted into black, grey, yellow, white, and lilies. They vary in length, and are separated by the workman striking a quantity held in the hand smartly on a bench, the thick ends downwards. He then applies them to a gauge to ascertain the lengths of those that project, and, seizing them between his finger and thumb, draws them out of the bundle and places them with those of corresponding dimensions. They are sorted according to thickness by a process called "dragging,"

which consists in passing them through a kind of comb, which retains those that are too stout to go between the teeth. By repeating this with finer combs the bristles can be assorted to any number of sizes required. Various other substances are now used in place of bristles, and this was greatly stimulated by the scarcity of these during the Russian war. In 1808 whalebone fibres were patented in England for the purpose, and in 1810 twigs of broom, mallow, rushes, and other shrubs and plants. In 1842 the shafts of quills prepared and split up, and in 1872 horn and similar substances were used in the same way. The latter are softened by steeping them in an infusion of sage leaves or plants of that class, then flattened, rolled out, and extended and moulded so as to disintegrate them into threads. In 1844 a brush was patented made of stiff fibre and bristles, hard in one part and soft in another, so that the softer parts should follow the harder, and take up what the latter left. The same inventor also made tooth-brushes on the same principle. The hairs of the squirrel, horse, badger, bear, and other animals are also used for brushes, and those from the ears of cows and from the ichneumon, amongst others, for artists' pencils. When necessary the bristles are bleached by sulphur or other chemical agents. In the United States a kind of sorghum or broom-corn is extensively cultivated for the manufacture of brooms, and especially by the Shakers of New York State. The seed of the crop alone, it is stated, often pays the expense of cultivation, being, when mixed with other corn, good food for cattle and horses.

One of the most important purposes to which brushes have been applied is that of sweeping chimneys. So far back as 1789 John Elin patented an arrangement of brushes with this purpose in view. He was followed at intervals by others, and the use of these machines having been found practicable, the Acts 3 and 4 Vict. c. 85, and 27 and 28 Vict. c. 37, put an end to the cruelties previously practised, prohibiting the employment of children in sweeping chimneys.

Revolving brushes for cleaning rooms were patented in 1811, and others have followed. In 1825 they were constructed to take the place of teazles for raising the wool or pile of woollen and other cloths, and they are now used for polishing and other purposes in various manufactures. The first patent in which they were applied to hair-dressing appears in 1862. The patented invention for sweeping and cleaning roads by means of revolving brushes and other contrivances are very numerous. The first appears in 1699. It is that of Edmund Henning for "a new engine for sweeping the streets of London, or any city or town." No specification was enrolled, but the invention included the loading and removal of the refuse "with great ease and quickness." A long interval elapsed before anything further was done in this direction, the next patent being that of W. Ranyard, on 1st November 1825, which consisted of a number of brushes mounted upon two rims or placed upon an axis, which was raised on a vehicle or barrow. Boase and Smith's followed in 1828, including scraping, sweeping, and watering. From 1836 a succession of inventors follow each other rapidly, amongst whom frequently appears "Joseph Whitworth." Some of the most recent patents are Greenwood's, 17th February 1873; Robinson's, 4th April 1874; Sinclair and Clayton's, 20th February 1875; Kitson's, 21st April 1875. Many of these inventions include the removal of the refuse, as well as scraping. Some propose watering in addition; but the simplest and most easily managed is that most commonly used, which scrapes or sweeps the mud and rubbish to the sides of the road. A particular point in Mr Kitson's invention seems to be to clear out the dust and mud from between the joints of the paving stones.

An improvement in brushmaking was patented in 1830 by Timothy Mason, which consisted in cutting grooves in the stocks or bases of brushes instead of boring holes, the grooves increasing in width from the outer surface. The hairs or bristles are tied up into tufts or knots, dipped in cement, placed in the grooves, and wedged tightly by the use of a blunt tool, which operation causes the tufts to expand and hold firmly in the enlarged recess. Various contrivances have been patented by which brushes might be self-supplied with water, soap, paste, paint, and the like, when in use, by means of receptacles or pipes being attached to them for the purpose.

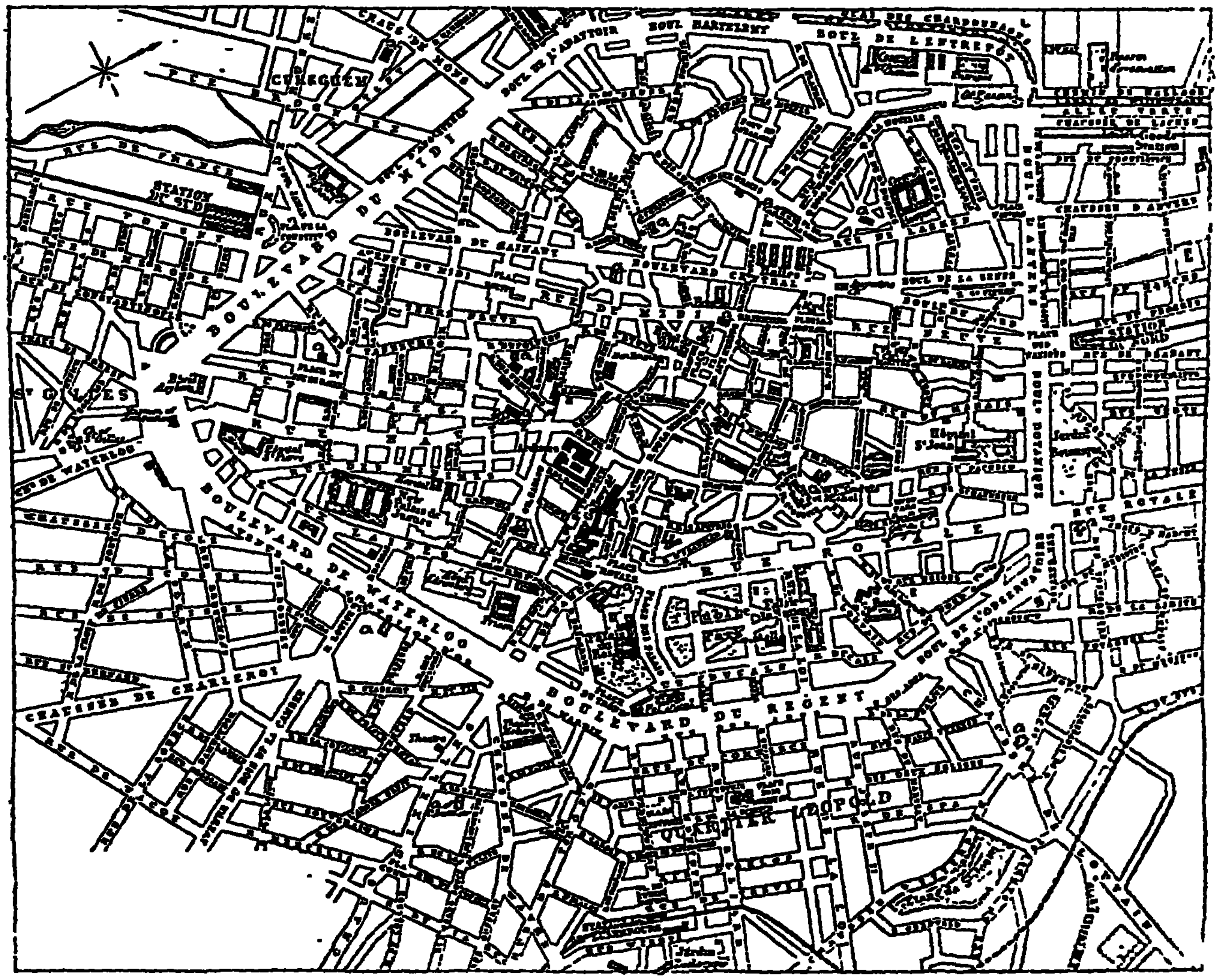
One of the greatest advances in the brushmaking of the present day is the Woodbury machine, an American invention for bunching, wiring, and inserting bristles in the stock. In this machine a metal comb of uniform thickness is filled with bristles, holding them by the middle, so that one-half of the bristles appear above the surface of the comb, the other underneath. The comb thus charged moves in guideways, and discharges the bristles from each division successively into a channel in which, by an ingenious contrivance, they are brought gradually into a horizontal position and a proper quantity taken up to form a tuft, which is moved along an incline. At the bottom of this is a hollow cylinder that does not enter, but is placed firmly against the tuft hole in the brush stock. A plunger now acts upon the bristles. The end of the plunger is slotted crossways; one slot receives the bristles, the other a piece of wire. The plunger is made to descend and double the bristles into a loop at the middle. Other mechanism unwinds the binding wire from a reel, straightens the wire, and passes the proper quantity through the enlarged upper portion of the slot, and at the same time cuts off the length required. The plunger now descends further, receiving a rotatory motion on its vertical axis, winds the wire by forcing it into the thread of a nut at the lower portion of the cylinder, and fastens it round the double end of the bunch. The end of the wire now acts as a tap, cutting a female screw in the end of the block, whilst the upper end of the wire thread, by expanding, acts as a pawl, and prevents the unscrewing of the tuft. This machine is described in the *Scientific American*, 1872, p. 31, with illustrations.

For further information on the subject of brushes, the reader will find the abridgement of specifications relating to brushing and sweeping, published at the Patent Office, a most useful manual. (J. J. L.)

BRUSSELS (French, *Bruxelles*; Flemish, *Brussel*; German, *Brüssel*), capital of Belgium and of the province of South Brabant, is situated on the small River Senne, about 50 miles from the sea, in 50° 51′ N. lat., 4° 22′ E. long. It lies in the midst of a beautiful and fertile country, and is picturesquely built on the top and sides of a hill, which slopes down to the Senne. The general contour of the old town of Brussels is pentagonal, and is well defined by the boulevards, which occupy the site of the old fortifications; but extensive additions have been made, especially to the east and south, and present a very irregular outline

Brussels may be considered to consist of two parts, each presenting characteristics peculiar to itself. The New Town or upper part of the city is dry and healthy, and contains a very large number of handsome buildings, both public and private. The lower part is the more ancient and interesting of the two, but is damp, and in summer unhealthy, from the exhalations of the river and the numerous canals. In the former are situated nearly all the public offices, the royal palace, the chamber of deputies, the residence of the foreign representatives, and the principal hotels. The latter contains the Hôtel de Ville, and

some of the best remains of the old Gothic architecture, and is the seat of nearly all the trade and commerce of the town. The facilities for commerce are very considerable. Though the Senne is not navigable itself, and is in fact now (1876) in process of being arched over to afford room for a new boulevard, it supplies water to some of the canals that intersect the lower portion of the city. By these canals Brussels communicates with the great Belgian cities, Mechlin, Ghent, Bruges, and Antwerp on the north, and Charleroi on the south. It further enjoys the advantage of railway communication with France and Germany, and the chief towns of the Belgian dominions. The streets are for the most part well paved, well lighted, and abundantly supplied with excellent water. There are in the town innumerable fountains, some of w' : h handsomely ornamented with sculptures in stone bronze. Of these the best are *Les Fontaines des Fleu.* the Hôtel de Ville, *La Fontaine de Minerve* in one c great squares, and the *Mannekin-pis* behind the Hôt Ville. Some of the streets are macadamized, but majority of them are causewayed, while the *trottoirs* either flagged or paved with flint-stones. In the new some of the streets are remarkably handsome; they con a considerable number of shops and cafés similar to t of Paris, and form the chief promenades of the tants. In the old town they are for the most part na and sombre. There are fourteen squares in B many of which are used as market-places. Of these



Plan of Brussels.

largest are the Place du Grand Sablon, the Place Royale, and the Grande Place before the Hôtel de Ville. In the last-named square, surrounded for the most part with houses that date from the time of the Spanish possession, the Counts Egmont and Horn were beheaded in 1568, by order of the duke of Alva, who surveyed the scene from the windows of the Brood-Huys (otherwise Maison du Roi), a remarkable specimen of Gothic architecture still extant. In the Place de la Monnaie are the mint, the exchange, and the great theatre. In the Place des Martyrs, the heroes who fell in the Revolution of 1830 are interred. In front of the palace is the Public Park, a fashionable summer promenade, which covers an area of about 14 acres. It is beautifully laid out with walks, adorned at moderate distances with groups of sculpture; and as it is planted with trees which shade it from the sun, the grass is always fresh and green. In the lower town is the Allée Verte, an equally fashionable promenade, which runs parallel with the Mechlin canal, having a triple row of linden trees on each side, and leads towards the village of Lacken, where, since 1815, the king has had a suburban castle.

Of the public buildings of Brussels the most remarkable are the cathedral church of St Michel et Ste Gudule, the Hôtel de Ville, and the Palace of Justice, a modern erection. The cathedral was built in 1010, and in it was held the first chapter of the order of the Golden Fleece in 15?5 It contains a remarkable pulpit, and some splendid specimens of stained glass. From its towers a fine view of the surrounding country may be obtained. The Hôtel de Ville, built in 1400, is profusely ornamented; it has a tower 360 feet in height. The other public buildings of Brussels are for the most part handsome, but are quite

uninteresting. The principal hospitals are those of St Peter and St John, which are both admirably managed, and contain together about 1000 beds. The patients are waited upon by the sisters of charity. As in all the large Belgian towns, there is, besides two other nunneries, a convent of Beguins, which formerly numbered 1000 nuns. The mass of the native population are Catholics; but as the English residents are very numerous, there are several Protestant churches. The Jews have a synagogue at Brussels, and hold their grand consistory there.

The number of charities in Brussels is very great; of these the most important are the Foundling Hospital, the Orphan Asylum, and the Société Philanthropique, whose object is to prevent mendicity. There are besides numerous alms-houses, which annually give relief to about 35,000 persons. Some of these establishments are supported entirely by subscription; others of them are subsidized by Government. Great attention is paid to the education of poor children. The communal expense for public instruction amounted in 1873 to 858,150 francs. Among the educational establishments are the gymnasium, the polytechnic school, the Royal Athenæum, a Lancasterian school, and many public and private academies, besides the Free University, which was founded in 1834 by a company belonging to the liberal party. The number of students at the university amounted in 1874 to nearly 580; while at the Royal Athenæum the number in the same year was 772. There is also a well-conducted veterinary and agricultural school.

Some of the societies of Brussels are very celebrated. The Royal Conservatorium of Music had 529 pupils on its roll in 1874. The Royal Society was founded in 1769. The geographical establishment of Vandermaelen, instituted in 1830, is in a flourishing condition. The botanical garden is one of the best in Europe, and there is also a large zoological garden. The Palais de l'Industrie contains an admirable museum of natural history, and an extensive and valuable collection of books and manuscripts, which is accessible to the public. The number of books is 234,000, of which 2000 belong to the 15th century, while the manuscript department, known as the *Bibliothèque de Bourgogne*, contains about 22,000 MSS., many of which are beautifully illuminated. From sixty to sixty-five thousand francs are annually voted for the maintenance of the library. Eminent literary men and others are sometimes allowed to take books home, but the number to whom this privilege is conceded never exceeds 100 annually. There are numerous printing and lithographic presses in constant operation in Brussels, a large number of the former being engaged in the republication of standard works that appear in France.

The principal manufactures of Brussels are those of lace and tulle, carpets, woollen, linen, and cotton fabrics, jewellery, and articles of vertu. The most remarkable of these is that of lace. The finer sorts of flax used in the manufacture cost from £12 to £16 sterling per lb. An English yard of this lace costs £8. The persons who spin the thread work in rooms almost completely darkened, and are thus compelled to concentrate their attention; and the thread spun in this way is said to be finer and more delicate than any that has hitherto been produced by other means. Excellent carriages are made in Brussels two-thirds cheaper than those of England, but inferior to them in quality.

In 1837, the population of Brussels was 104,265; in 1846, 123,874; in 1849, 138,189; in 1850, 142,289; and in 1873, 180,172. At the last date there were 365,404 in the nine contiguous communes. In 1846, the houses in the town numbered 13,563, and in 1866, 18,543.

The history of Brussels, though it does not date from so remote a period as that of other Flemish cities, can still be clearly traced back to the 7th century. At that time St Gery, bishop of Cambray, built a chapel on one of the small islands in the river, and by his eloquence and piety soon attracted a large congregation. The site being well adapted for building, a hamlet soon sprung up, and speedily became a town, which in the 11th century was walled in and fortified. Though in commercial importance Brussels did not at this time equal Ghent or Bruges, its traffic in cloth was very considerable, and its workers in iron and steel were not surpassed by any in Europe. In the 14th century the various trades were incorporated into guilds, who regulated the taxes and other financial matters of the city, and drew up a code of municipal laws, in which the principle of trial by jury was admitted. These arrangements had scarcely been completed, when a dreadful fire visited the city and nearly burnt it to the ground. At the end of this century a general persecution of the Jews in Europe took place. In Brussels, many of them were put to death, and the value of the confiscated property amounted to upwards of half a million sterling. At the beginning of the 15th century, Brussels was again visited by a destructive fire, from the effects of which it speedily recovered by the patriotic exertions of its rulers, and soon became more distinguished than ever as a seat of learning, art, and science. In 1489, and again in 1587, it was visited by the plague, which, on the former of these occasions, carried off many thousands of the inhabitants. Its horrors were enhanced by the ensuing famine, which lasted for four years.

Brussels was highly favoured by Charles V., who often resided in the city, and raised it to the rank of capital of the Netherlands. Under his son Philip II. it became the centre of the great revolutionary movement, which resulted in the independence of the United Province. In 1598 Brussels passed into the dominion of the Austrians, and soon began once more to prosper. In 1695 the French under Marshal Villeroy besieged Brussels, but were obliged to retire after doing much damage to the town; and in 1706 the city opened its gates to Marlborough. In 1746 it was again besieged by the French under Marshal Saxe, and after a siege of three weeks was obliged to surrender. In 1792 it fell into the hands of General Dumouriez, who being soon after defeated at Louvain, evacuated Brussels for a while, but again entered it in 1794. From that year till 1814, it remained in the possession of the French, as capital of the department of the Dyle. On the fall of Napoleon, Belgium and Holland were united into one kingdom under William of Nassau, and Brussels was the seat of government alternately with the Hague. In 1830, however, after a sanguinary conflict of four days in the streets of the city, the Belgians declared their independence; and erecting their state into a separate kingdom, offered the crown to Leopold of Saxe-Coburg, whose long and peaceful reign (1831–1865) contributed greatly to the development of the resources of the country.

BRUTON, a market-town of England, in the county of Somerset, pleasantly situated in the valley of the Brue, about 10 miles S.S.W of Frome by rail. It has a town-hall, a hexagonal market-cross, a grammar school, and some manufactures of hair-cloth, woollens, and hosiery. Population of hundred in 1871, 3701.

BRUTUS. The name of a distinguished plebeian family at Rome. The first who bore it was LUCIUS JUNIUS BRUTUS, one of the first two consuls, 509 B.C. According to the legends, his mother was the sister of Tarquinius "Superbus," the last of the Roman kings, and at his father's death, his elder brother had been put to death by the reigning family in order to get possession of his wealth. Junius, the younger, owed his safety to his reputed

dulness of intellect (whence his surname of Brutus), which character, however, he had assumed with a view both to his present security and future revenge. The opportunity came when Lucretia, wife of Collatinus, was outraged by Sextus Tarquinius; and he took a leading part, together with her husband and father, in expelling the family of the Tarquinii from Rome. He and Collatinus were therefore elected consuls,—or rather prætors, which was the original title. In a conspiracy formed afterwards for the restoration of the banished dynasty, the two sons of Brutus were found to be deeply implicated, and were executed by sentence of their father, and in his sight. The Etruscans of the cities of Veii and Tarquinii making an attempt to restore Tarquinius to the throne, a battle took place between them and the Romans, in which Junius Brutus engaged Aruns, son of the deposed king, in single combat on horseback, and both fell by each other's hands. The Roman matrons are said to have mourned a year for him, as "the avenger of woman's honour," and a statue was erected to him on the Capitol.

Many members of the family rose to eminence in the Republic, and are found, as plebeians, ranged on the popular side. The most distinguished of these was Decius Junius Brutus, consul, 325 B.C.

In later times came Marcus Junius Brutus, a jurist of high authority, considered as one of the founders of Roman civil law, to whom Cicero dedicates his treatise called *Orator*. His son, of the same name, made a great reputation at the Roman bar, chiefly by undertaking prosecutions, and from the vehemence and bitterness of his speeches became known as "the Accuser."

Decius Junius Brutus first served under Julius Cæsar in Gaul, and afterwards commanded his fleet, and was held by him in great honour and esteem. Nevertheless, whether from patriotism or from lower motives, he joined in the conspiracy against his patron, and, like his relative Marcus Junius Brutus, was one of his assassins. He afterwards resisted the attempt of Antony to obtain absolute power; and after heading the republican armies against him for some time with success, was deserted by his soldiers in Gaul, betrayed by one of the native chiefs, and put to death by order of Antony, 43 B.C.

Best known of all is Marcus Junius Brutus, son of a father of the same name (treacherously put to death by order of Pompey during the civil wars), and of Servilia, sister of Cato of Utica. Young Marcus was only eight years old at his father's death, and was educated with great care by his mother and uncles. He at first practised as an advocate. In spite of his father's fate, he at first supported the cause of Pompey against Cæsar, but was pardoned by the latter after the victory of Pharsalia, and subsequently appointed by him to the government of Cisalpine Gaul. His justice and moderation won him great honour from the provincials under his rule. Influenced probably by his friend Caius Cassius, he afterwards joined in the conspiracy against the great dictator, and was one of the foremost in his assassination. He maintained the cause of the republic by seizing and holding against Antony's forces the province of Macedonia, where he was joined by Cassius. But at Philippi they were defeated by Antony and Octavianus Cæsar, and rather than be taken prisoner, he fell on his sword, 42 B.C. He was an earnest student through all his active life, and is said to have been employed in his tent, on the night before the battle of Pharsalia, in making an abridgment of Pausanias.[1] He wrote several philosophical treatises and some poetry, but nothing has survived. He combined with these tastes the incongruous occupation of a money-lender, Cicero and King Ariobarzanes being amongst his clients. His second wife was his cousin Portia, daughter of Cato.

[1] "Is not the leaf turned down
Where I left reading?"
Shaksp. *Jul. Cæsar*, Act iv. sc. 3.

BRUTUS, or Brute, is asserted in the fabulous history of Geoffrey of Monmouth to have been the grandson of Æneas, and to have destroyed the race of giants in Britain, to which he gave his name, founding there the city of New Troy, afterwards London.

BRÜX, a city in the circle of Saatz, in the Austrian kingdom of Bohemia, on the River Bila. It consists of an old town, surrounded with walls, and three suburbs, and contains, besides the courts and public offices of the circle, nine churches, three monasteries, a gymnasium, barracks, a military college, and an educational establishment of Piarists. Its inhabitants are partly engaged in the coal-mines, and in the preparation of salts from the Seidlitz waters in the vicinity. A battle was fought here in 1421 between the Hussites and Saxons; and in 1646 the Swedes captured the fort of Landswert, now dismantled. Population in 1869 (including Taschenberg), 6102.

BRUYÈRE, Jean de la. See La Bruyère.

BRYANT, Jacob (1715-1804), a writer on theological and mythological subjects, was born at Plymouth in 1715. His father had a place in the customs there, and was afterwards stationed in Kent, where his son was first sent to a provincial school, whence he was removed to Eton. Here he appears to have remained till 1736, the date of his election to King's College, Cambridge, where he took his degrees of bachelor and master of arts in 1740 and 1744. He returned to Eton in the capacity of private tutor to the duke of Marlborough, then marquis of Blandford; and the good taste which his pupil showed through life, in the protection of the fine arts, and in the pursuit of science, sufficiently demonstrated the beneficial influence of his instructor's example. In 1756 he went to the Continent as private secretary to the duke of Marlborough, then master-general of the ordnance and commander-in-chief of the forces in Germany; and he was rewarded after his return, for his various services to the family, by a lucrative appointment in the ordnance, which allowed him ample leisure to indulge his literary tastes. Bryant died in his eighty-ninth year, on the 14th November 1804, in consequence of a fall from his chair while reaching up for a book in his library. He left his library to King's College, having, however, previously made some valuable presents out of it to the king and to the duke of Marlborough. He bequeathed £2000 to the Society for the Propagation of the Gospel, and £1000 for the use of the superannuated collegers of Eton School.

His principal works are the *New System or Analysis of Ancient Mythology, wherein an attempt is made to divest tradition of fable, and to reduce truth to its original purity*, 3 vols. 4to, 1774-76, which is fantastic and now wholly valueless; *An Address to Dr Priestley on the Doctrine of Philosophical Necessity*, 8vo, 1780; *Vindiciæ Flavianæ; Observations on the Poems of Thomas Rowley, in which the authenticity of these poems is ascertained*, 2 vols. 12mo, 1781; *Treatise on the Authenticity of the Scriptures, and the Truth of the Christian Religion*, 1792; *Observations upon the Plagues inflicted upon the Egyptians*, 8vo, 1794; *Observations on a Treatise, entitled Description of the Plain of Troy, by Mr de Chevalier*, 4to, 1795; *A Dissertation concerning the War of Troy, and the expedition of the Greeks, as described by Homer, showing that no such expedition was ever undertaken, and that no such city in Phrygia existed*, 4to, 1796; *Observations on the Vindication of Homer, written by J. B. S. Morritt, Esq.*, 4to, 1799; *The Sentiments of Philo Judæus concerning the Word of God*, 8vo, 1797; *Dissertations on various Subjects in the Old Testament*.

BRYAXIS, a Greek sculptor, the contemporary of Scopas and Praxiteles, with whom he took part in the sculptures of the mausoleum at Halicarnassus, about 345 B.C. Of his other works the following are mentioned:—five colossal figures of gods at Rhodes, Bacchus (*Liber Pater*) at Cnidus, a group of Æsculapius and Hygeia at Megara, Apollo in the grove of Daphne at Antioch, a statue of Pasiphaë, and

a portrait of Seleucus (it is not said which). On doubtful authority he is also said to have been the sculptor of a group of Jupiter and Apollo with a lion at Patara, and of a statue of Serapis. Before his time there is no mention of statues of Æsculapius or Serapis, and it is supposed that the types which we now have of these deities were introduced by Bryaxis. The statue of Apollo at Daphne represented the god in his character of Musagetes, with long flowing drapery girt at the waist. The Bacchus at Cnidus must have been similarly draped; and altogether Bryaxis seems to have shown as much preference for draped and mature forms as Praxiteles displayed for nude and youthful figures.

BRYDGES, Sir Samuel Egerton (1762–1837), a miscellaneous writer, was born 30th November 1762. He studied at Queen's College, Cambridge, and adopted the profession of law. In 1790 he persuaded his elder brother that their family were the heirs to the barony of Chandos, being descended from a younger branch of the Brydges who first held the title The case was tried and lost, but Brydges never gave up his claim, and used to sign himself *Per legem terræ* B. C. of S. (*i.e.* Baron Chandos of Sudeley). It has been said that he underwent the labour of re-editing Collins's *Peerage*, for the sole purpose of inserting a statement about his supposed right. In 1814 he was made a baronet, and in 1818 he left England. He died at Geneva in 1837. Sir Egerton was a most prolific author; he is said to have written 2000 sonnets in one year. His first volume of poems was published in 1785; of his other numerous works, including novels, political pamphlets, and bibliographies, perhaps the most important are *Censurà Literaria*, 10 vols., 1805–9, and *Autobiography, Times, Opinions, and Contemporaries of Sir S. E. Brydges*, 1834.

BRZEZANY, a town of Austria, in Galicia, S.E. from Lembergo n the River Zlota-Lipa, in 49° 30′ 25″ N. lat. and 24° 41′ 39″ long. It possesses a Roman Catholic, a Greek, and an Armenian church, a castle, a convent, and a gymnasium; and it carries on a considerable manufacture of linen and leather. The population in 1869, including some contiguous villages, amounted to 9290.

BUBASTIS, the great name of the Egyptian goddess Bast, supposed to hold the same place in the Egyptian Pantheon as Artemis or Diana. The triad of Memphis consisted of three gods—Ptah or Vulcan, the Greek Hephaistos; Bast, the wife of Ptah and mother by him of Nefer-Atum, or "the good Tum;" and Sexet, formerly called Pasht, the sister or antithesis of Bast. This last goddess was also called *Merienptah*, or "the beloved of Ptah." Although the names of Bast, Sexet, and Merienptah are written with different hieroglyphs, their types are exactly alike, being that of a lion-headed goddess having on her head the sun's disk entwined by an uræus. Sexet and Bast appear both to have personified fire acted upon by Ptah, the cosmic demiurgos, and Vulcan. Owing to the pantheistic ideas prevalent in Egypt, Bast was identified at times with Neith, the Egyptian Athene or Minerva, and Athor, the Aphrodite or Venus. Her type and attributes were also those of Tefnu or Daphne, the pupil or daughter of the sun; and it was probably from her relation to this goddess, who, with her twin brother Su or Sôs, represented the Apollo and Artemis of the religious, and the Gemini, or Twins, of the zodiacal system, that Bast was identified with Diana. Bast was supposed to be the beneficent portion of the element fire and the bringer of good fortune; her sister and rival Sexet to represent the malevolent deity of the element and the bringer of ill-fortune. At a later period Bast has the head of a cat substituted for that of a lion, and holds in her hands a vase or situlus. About the time of the 26th dynasty, figures of her, made of porcelain, abound, representing the goddess seated and sometimes holding a sistrum. Her local worship was principally carried on at Bubastis, the modern Tel-Basta. The Speos Artemidos, or Sheik Hassan, Anxtata supposed to be Letopolis near Memphis. The cat was sacred to this goddess, and mummies of this animal are found at Bubastis, the Speos Artemidos, and Thebes, sometimes in bronze or wooden figures in shape of the cat seated on a pedestal, carved in form of the vase which was the hieroglyphic name of the goddess. Connected with Bubastis were the Bubasteia or festival of the goddess, celebrated with great pomp at the city of Bubastus, and the largest and most important in Egypt. The Egyptians flocked to it by water, accompanied by music; and as many as 700,000 are said to have been present on the occasion. A nome was also named after this goddess, and the capital city called Bubastus or Bubastis was on the site of the present Tel Basta on the Bubastite branch of the Nile. In later times the canal of Necho started from it to the Red Sea, and the adjoining lands were given by Psammetichus to the Greek mercenaries. It is, however, mentioned in inscriptions of the earlier periods of history, and was an important city. Taken by the Persians under Memnon, its walls were razed, and it sunk gradually in importance. The nome struck some bronze coins of small size in the eleventh year of the Emperor Hadrian, 127 A.D., with a goddess holding in her hands a small animal, possibly a cat. Many antiquities and remains are found in the ruins of the city.

Brugsch, *Geogr. Inschrift*, i. 138-236; Jablonski, *Panth. Ægypt.*, iii. p. 68; Diodorus, i. 27; Herodot. ii. 67, 137-156; *Rev. Arch.* 1863, 195; Wilkinson, *Mann. and Cust.*, iv. 277, v. 203.

BUCCANEERS, a band of piratical adventurers of different nationalities united in their opposition to Spain, who maintained themselves chiefly in the Caribbean Seas during the 17th century.

The island of St Domingo was one of several in the West Indies which had early in the 16th century been almost depopulated by the oppressive colonial policy of Spain. Along its coast there were several isolated establishments presided over by Spaniards, who were deprived of a free and convenient market for the produce of the soil by means of the monopolies imposed by the mother country. Accordingly English, Dutch, and French vessels were welcomed with eagerness, and their cargoes readily bought. The island, thinned of its former inhabitants, had become the home of immense herds of wild cattle, which multiplied with great rapidity; and it became the habit of the hardy smuggler to provision his ship at St Domingo. The natives still left upon the island were skilled in preserving flesh by means of fire and smoke at their little establishments called Boucans. The adventurers learned "boucanning" from the natives; and gradually Hispaniola became the scene of an extensive and illicit butcher trade. A sailor in those days when piracy abounded was expert with his weapons, and was almost a fighting man by trade. Spanish monopolies were the pest of every port from Mexico to Cape Horn; and the seamen who had sailed the Caribbean were filled with a natural hate of everything Spanish. The pleasures of a roving life gained upon them, while the monotony of its routine was broken by occasional skirmishes with the forces organized and led by Spanish officials. Out of such conditions arose the Buccaneer, alternately sailor and hunter, even occasionally a planter,—roving, bold, not overscrupulous, not unfrequently savage, with an intense detestation of the power and the representatives of Spain.

In the year 1625 indirect assistance and encouragement previously given culminated in a combined venture on behalf of the Buccaneers by the Governments of England and France. Each nation contributed a band of colonists, and selected the island of St Christopher, in the West

Indies, where the settlers of both nations were simultaneously planted. The English and French were, however, not over-friendly; and in 1629, after the retirement of several of the former to an adjoining island, the remaining colonists were surprised and partly dispersed by the arrival of a Spanish fleet of thirty-nine sail. Many were carried off, and threats were freely used as to the future settlement of the island. But on the departure of the fleet the scattered bands returned, and encouragement was given to their countrymen in St Domingo. For buccaneering had now become a most profitable employment, operations were extended, and a storehouse secure from the attacks of the Spaniards was required. The small island of Tortuga lying to the N.W. of Hispaniola was seized for this purpose in 1630, converted into a magazine for the goods of the rivals, and made their headquarters, St Domingo itself still continuing their lucrative hunting ground.

Spain was not indifferent to this proceeding, though she could not prudently take immediate action. Eight years, however, had not gone, ere, watching her opportunity when many Buccaneers were absent in the larger island on their ordinary pursuit, she attacked Tortuga, and massacred every settler she could seize. But the hunters to the number of 300 returned; and the Buccaneers, now distinctly seen to be in open hostility to the Spanish arms, began to receive recruits from every European trading nation, and for three-quarters of a century became the acknowledged scourge of the Spanish American trade and dominions.

France, throughout all this, had not been idle in watching over her own interests. She had named the Governor of St Christopher "Governor-General for the French West India Islands," and in 1641 he took possession of Tortuga for the Crown of France, expelled all English from the island, and attempted the same with less success in St Domingo. England had at home something vastly more important to attend to, and the Buccaneers had to maintain themselves as best they could,—now mainly on the sea.

In 1654 the Spaniards regained Tortuga from the French, into whose hands it again, however, fell after a period of six years. But this state of matters was, as may be readily conceived, too insecure even for these rovers, and they would speedily have succumbed to the perils of their mode of life, had not a refuge been found for them by the fortunate conquest of Jamaica in 1655 by the navy of Cromwell, on behalf of the English Commonwealth. These conquests were not made without the aid of the Buccaneers themselves. The taking and retaking of Tortuga by the French was always with the assistance of the roving community; and at the conquest of Jamaica the English navy had the same influence in its favour. The Buccaneers, in fact, by this time constituted a mercenary navy, ready for employment against the power of Spain by any other nation, on condition of sharing the plunder to be obtained; and they were noted for their daring, their cruelty, and their extraordinary skill in seamanship.

Their history now conveniently divides itself into three distinct epochs. The first of these extends from the period of their rise to the capture of Panama by Morgan in 1671, during which time their characteristic peculiarity as robbers was that they were hampered neither by Government aid nor, till near its close, by Government restriction. The second, from 1671 to the time of their greatest union and power, 1685, when the scene of their operations was no longer merely the Caribbean, but principally the whole range of the Pacific, from California to Chili. The third and last period extends from that year onwards; it was a time of disunion and disintegration, when the independence and rude honour of the previous periods had degenerated into unmitigated vice and brutality.

It is chiefly during the first period that those leaders flourished whose names and doings have been associated with all that was really influential in the exploits of the Buccaneers,—the most prominent being Mansvelt and Morgan. The commerce of Spain, which had been gradually dwindling since the wreck of the Invincible Armada and the death of Philip II., had by the middle of the 17th century become utterly insignificant. The Buccaneers were thus deprived of the plunder of the Spanish mercantile marine. But Spanish settlements remained; and in 1654 the first great expedition on land, attended by considerable difficulties, was completed by the capture and sack of New Segovia in Honduras, on the mainland of America. The Gulf of Venezuela, with its towns of Maracaibo and Gibraltar, were attacked and plundered under the command of a Frenchman named L'Ollenois, who performed, it is said, the office of executioner for the whole crew of a Spanish vessel manned with ninety seamen. Such successes removed the Buccaneers further and further from the pale of ordinary civilized society, fed their revenge, and inspired them with an avarice almost equal to that of the original settlers from Spain. Mansvelt, indeed, in 1664, popular among all the Buccaneers, conceived the idea of their permanently settling as a body of regular colonists upon a small island of the Bahamas, named Providence, and Henry Morgan, a Welshman, intrepid and unscrupulous, joined him in some preliminary cruises. But the untimely death of Mansvelt nipped in the bud the only rational scheme of permanent settlement which seems at any time to have animated the members of this wild community; and Morgan, now elected commander, swept the whole Caribbean, and from his headquarters in Jamaica led triumphant expeditions to Cuba and the mainland. He was leader of the expedition wherein Porto Bello, one of the chief and best fortified ports in the West Indies, was surprised, taken, and plundered.

But this was too much for even the adverse European powers; and in 1670 a treaty was concluded between England and Spain, proclaiming universal peace and friendship among the subjects of the two sovereigns in the New World, formally renouncing hostilities of every kind, withdrawing commissions granted to privateers, and agreeing to forget the past and for the future to punish all offenders. Great Britain was to hold all her possessions in the New World as her own property (a remarkable concession on the part of Spain), and consented, on behalf of her subjects, to forbear trading with any Spanish port without licence obtained. On the proclamation of the treaty in Jamaica, the Buccaneers rose to a man, ready for the most daring exploit which it had yet been in their power to achieve; they resolved to carry the terror of their name to the shores of the Pacific.

Accordingly, in 1671 Morgan embarked 2000 men on board a fleet of thirty-nine ships, sailed for a convenient port in the Caribbean, and crossed the Isthmus to lay siege to Panama. After a difficult journey, on foot and in canoes, they found themselves nearing the shores of the South Sea and in view of the turrets of the fated city. On the morning of the tenth day they commenced an engagement which, ere the close of the evening, ended in the rout of the defenders of the town. It was taken, and, accidentally or not, it was burnt. Neither sex nor condition was spared in the barbarities which ensued; and the conquerors returned laden with spoil. Morgan was not even true to his own men in the division of the booty; he returned to Jamaica, became respectable under Government, was after a little made deputy governor of the island, and took advantage of his position to punish his

former associates. He died, by the favour of Charles II, the "gallant" Sir Henry Morgan.

From 1671 to 1685 is the time of the greatest daring, prosperity, and maritime power of the Buccaneers. But the expedition against Panama had not been without its influence. Notwithstanding the vigour with which they executed their piratical projects in the Caribbean, and the many successes which they obtained on land, including a second plunder of the unfortunate city of Porto Bello, their thoughts ran frequently on the great expedition across the Isthmus, and they pictured to themselves the shores of the South Sea as a far wider and more lucrative field for the display of their united power.

In 1680 those longings took formidable shape. A body of marauders over 300 strong, well armed and provisioned, landed on the shore of Darien and struck across the country; and the cruelty and mismanagement displayed in the policy of the Spaniards towards the Indians were now in small part revenged by the assistance which the natives eagerly rendered to the adventurers. They acted as guides during a difficult journey of nine days, kept the invaders well supplied with food, provided them with skilfully constructed canoes, and only left them after the taking of the fort of Santa Maria, when the Buccaneers were fairly embarked on a broad and safe river which emptied itself into the South Sea. With John Coxon as commander they entered the Bay of Panama, where rumour had been before them, and where the Spaniards had hastily prepared a small fleet to quell this dangerous attempt to carry insecurity and terror into the Pacific. But the valour of the Buccaneers won for them another victory, and within a week they escaped from the confinement of canoes, and took possession of a small fleet of four Spanish ships; and now successes flowed upon them. The Pacific, formerly free from their intrusion, showed many sail of merchant vessels, while on land opposition south of the Bay of Panama was of little avail, since few were acquainted with the use of fire-arms, and defence as an art was utterly unknown Coxon and seventy of his men returned as they had gone, but the others under Sawkins, Sharp, and Watling, roamed north and south, on islands and mainland, and remained for long ravaging the coast of Peru. Never scant of silver and gold, but often in want of the necessaries of life, they continued their practices for a little longer; then, evading the risk of recrossing the Isthmus, they boldly cleared Cape Horn, and arrived in the Indies, in the not very tender hands of the representatives of the different Governments there. Again in 1683, however, numbers of them under John Cook departed for the South Sea by way of Cape Horn, near which they hailed a Thames built ship fitted out apparently as a trader, but in reality for the purposes of privateering. Thus straight from England the Buccaneers were now receiving a great accession to their numbers and their strength; and Eaton, the commander of the new vessel, told Cook of a certain Captain Swan who would probably be met with soon, prosecuting the same dangerous business. They sailed northward, and on the death of Cook, Edward Davis, undoubtedly the greatest and most prudent commander who ever led the forces of the Buccaneers at sea, took command of his ship. Davis parted with Eaton, who left for the East Indies, but Swan arrived, and the two captains began a cruise which was disastrous to the Spanish trade in the Pacific.

In 1685 they were joined in the Bay of Panama by large numbers of Buccaneers who had crossed the Isthmus under Townley and others. This increased body of men required an enlarged measure of adventure, and this in a few months was supplied by the Viceroy of Peru. That officer, sole representative of the Spanish sovereign in the vast kingdom, saw that the trade of the colony was cut off, that supplies were stopped, that towns were burned and cleared of the precious metals, and that settled life was broken in upon by the harassing and repeated attacks of the unsparing marauders, and he resolved by vigorous means to put an end to this state of matters. But this was not easily accomplished. In this same year, indeed, a fleet of fourteen sail hove in sight of the united forces of the Buccaneers in the Bay of Panama. The ten ships of the pirates were miserably deficient in cannon, and hung off. The Spaniards evidently were not aware of their advantage, and the two fleets, after remaining in proximity for three days, separated without testing their strength except in the way of a small and distant cannonade.

At this period the power of the Buccaneers was at its height. But the combination was now too extensive for its work, and the different nationality of those who composed it was a source of growing discord. Nor was the dream of equality ever realized for any length of time. The immense spoil obtained on the capture of wealthy cities was indeed divided equally among the crew of the attacking ships, the commander alone getting an extra share. But in the gambling and debauchery which followed, nothing was more common than that one-half of the conquerors should find themselves on the morrow in most pressing want; and while those who had prudently retained or fortunately increased their store of the precious metals would willingly have directed their course homewards, the others clamoured for renewed attacks upon the hated Spaniards. The separation of the English and French Buccaneers, who together presented a united front to the Spanish fleet in 1685, marks the beginning of the third and last epoch in their history—that of disunion, decay, and extinction as an unaided community.

The brilliant exploits begun in this third period by the sack of Leon and Realejo by the English under Davis have, even in their variety and daring, a sameness which deprives them of interest, and the wonderful confederacy is now seen to be falling gradually to pieces. The skill of Davis at sea was on one occasion displayed in a seven days' engagement with two large Spanish vessels, and the interest undoubtedly centres in him. Townley and Swan had, however, by this time left him, and after cruising together for some time, they, too, parted. In 1688 Davis cleared Cape Horn and arrived in the West Indies, while Swan's ship, the "Cygnet," was abandoned as unseaworthy, after sailing as far as Madagascar. Townley had hardly joined the French Buccaneers remaining in the South Sea ere he died, and the Frenchmen with their companions crossed New Spain to the West Indies. And thus the Pacific, ravaged so long by this powerful and mysterious band of corsairs, was at length at peace from California to Cape Horn.

The West Indies had by this time become hot enough even for the banded pirates. They hung doggedly along the coasts of Jamaica and St Domingo, but their day was nearly over. Only once again—at the siege of Carthagena—did they appear great; but even then the expedition was not of their making, and they formed an accession to regular forces organized in France. After the treachery of the French commander of this expedition a spirit of unity and despairing energy seemed reawakened in them; but this could not avert and scarcely delayed the rapidly approaching extinction of the community.

The proximate causes of the disappearance of this remarkable body of men are to be found in European policy. The accession of William of Orange to the English throne in 1689 had raised the jealousy of Louis XIV., and the war which ensued was protracted and severe. French and English rovers in the Caribbean could

not but take the part of their countrymen at home, and the continuance of hostilities effected the severance of the bond of unity which had for three-quarters of a century kept the subjects of the two nations together in schemes of aggression upon a common foe. The peace of Ryswick in 1697 only left England and France free to pay court to Spain, whose king, weak in body and mind, was evidently hastening to the grave. The succession to the crown was believed to depend upon his will, and the two nations used all their influence, both in the Old World and in the New, to ingratiate themselves into the favour of the Spanish monarch. But that which really stopped the career of the Buccaneers so effectually as to prevent its being resumed was the fact, of so vast importance in the history of Spain and of Europe, that in 1700 Philip V., first of the Bourbon dynasty, ascended the Spanish throne. Spain, so little in herself, yet always great under great kings, now degraded and fallen, almost immediately rose before the eyes of astonished Europe as a gigantic power in the Old World and in the New.

But the fall of the Buccaneers is no more accounted for fully by these circumstances than is their rise by the alienation and massacre of the islanders of St Domingo. There was that in the very nature of the community which, from its birth, marked it as liable to speedy decline.

The principles which bound the Buccaneers together were, first, the desire for adventure and gain, and, in the second place, hatred of the Spaniard. The first, as that which could produce union among men of different nationalities, hardly deserves to be called a principle. There was perhaps much to gain, but it could be had nearly always by private venture under the colours of the separate European powers. Only one thing prevented this, and it is connected with their second and great principle of union, namely, that they warred not with one another, nor with every one, but with a single and a common foe. For while the Buccaneer forces included English, French, and Dutch sailors, and were complemented occasionally by not inconsiderable bands of native Indians, the instances during the time of their prosperity and growth are few in which we find them turning upon one another, and treating their fellows with the savagery which they exulted in displaying against the subjects of Spain. The exigencies, moreover, of their perilous career readily wasted their suddenly acquired gains.

Settled labour, the warrant of real wealth, was beneath the dignity of those who lived by promoting its insecurity. Regular trade—though rendered attractive by smuggling—and pearl gathering and similar operations which were spiced with risk, were open in vain to them. For, as the licence of the debauchee was in almost every case substituted for the cares and pleasures of domestic life, so a hand-to-mouth system of supply and demand rooted out gradually the prudence which accompanies any mode of settled existence. In everything permanency was what was not aimed at, because the whole policy of the Buccaneers, from the beginning to the end of their career, was one of pure destruction, and was therefore ultimately suicidal.

It has already been seen how great was the influence of the Buccaneers upon the power and the colonial tactics of Spain. But it was more beneficial to the world and more ruinous to Spain, that they opened the eyes of the world, and specially of the nations from whom these Buccaneers had sprung, to the whole system of Spanish American government and commerce—the former in its rottenness, and the latter in its possibilities in other hands. That effected, all was effected, since the extent of Spanish power was known. From this, then, along with other causes, dating primarily from the helplessness and presumption of Spain, there arose the West Indian possessions of Holland, England, and France.

A work published at Amsterdam in 1678, entitled *Americaensche Zee Roovers*, from the pen of a Buccaneer named Exquemelin, was translated into several European languages, receiving additions at the hands of the different translators. The French translation by Oexmelin is named *Histoire des Avanturiers qui se sont signalez dans les Indes*; the English edition is entitled *The Bucaniers of America*. Other works are Raynal's *History of the Settlements and Trade of the Europeans in the East and West Indies*, book x., English translation 1782; Dampier's *Voyages*; Geo. W. Thornbury's *Monarchs of the Main, &c.*, 1855; Lionel Wafer's *Voyage and Description of the Isthmus of America*, 1699; and the *Histoire de l'isle Espagnole, etc.*, and *Histoire et description générale de la Nouvelle France* of Père Charlevoix. The statements in these works are to be received with caution. A really authentic narrative, however, is Captain James Burney's *History of the Buccaneers of America*, London, 1816. (T. S.)

BUCCARI, a royal free town of the Hungarian crown, situated in the comitat of Fiume, on a small bay of the Adriatic, in *45° 18′ 46″ N. lat.* and *14° 32′ 11″ E. long.* Its harbour is of rather limited dimensions, but the roadstead is excellent, though the approach is not unattended with danger. The staple industry is the weaving of linen; shipbuilding is also carried on, and there is an active coasting trade in fish, wine, wood, and coal. The tunny-fishery is of some importance. In the neighbourhood of the town is the old castle of Buccaricza, and further south the flourishing little port of Porto Rè or Kraljevicza. The population of Buccari in 1869 was 2116.

BUCCINO, a town of Italy in the province of Principato Citeriore, and district of Campagna, situated on the River Botta, which is here crossed by an ancient Roman bridge. Buccino is identified by means of inscriptions found on the spot, as the ancient *Volceium* or *Volcentium*, which was a considerable municipal town in Lucania. Population, 6049.

BUCER, MARTIN (1491–1551), originally MARTIN KUHORN, an eminent German reformer, born at Schelestadt, a town of Alsace, near Strasburg. At the age of fifteen he entered the order of St Dominic, and as he was a youth of great promise he was sent to prosecute his studies at Heidelberg. There he studied the works of Erasmus and Luther, and was present at a disputation of the latter with some of the Roman Catholic doctors. He became a convert to the Reformed Church, abandoned his order, and soon afterwards married a nun. He did not, however, remain strictly a Lutheran. On the great question of the sacrament of the Lord's Supper, his opinions were decidedly those of Zwingli rather than of Luther. Although differing from them in doctrine he was anxious to be in church unity with the Lutheran party, and constantly endeavoured to bring about a coalition. In 1548 he was sent for to Augsburg to sign the agreement, called the *Interim*, between the Papists and Protestants. His warm opposition to this project exposed him to many difficulties and hardships, which induced him to accept the invitation of Archbishop Cranmer to fix his residence in England. On his arrival, in 1549, he was appointed to teach theology in the university of Cambridge. King Edward VI. had the greatest regard for Bucer. Having heard that he had suffered much from the cold, from want of a German stove, he sent him a hundred crowns to purchase one. Bucer died of a complication of disorders in 1551, and was buried at Cambridge with great funeral pomp. Five years afterwards, in Mary's reign, his body was dug up and burnt, and his tomb demolished; but it was subsequently re-constructed by order of Queen Elizabeth. Bucer's name is familiar in English literature from the use made of the reformer's doctrines by Milton in his divorce treatises.

BUCH, LEOPOLD VON (1774–1853), an eminent German geologist and geographer, was born at Stolpe in Pomerania, April 25, 1774. In 1790 he studied at the mining school of Freiberg under the celebrated Werner, one of his

fellow-students there being the illustrious Alexander Von Humboldt. At the age of twenty-three he published his *Attempt at a Mineralogical Description of Landeck*, and also an *Attempt at a Geognostic Description of Silesia*. He was at this time a zealous upholder of the Neptunian theory of his illustrious master. In 1797 he met his old school-fellow Von Humboldt at Salzburg, and with him explored the geological formations of Styria and the adjoining Alps. In the spring of the following year, Von Buch extended his excursions into Italy, where his faith in the Neptunian theory was for the first time shaken. In his previous works he had advocated the aqueous origin of basaltic and other formations; he was now not less clearly convinced that these owed their existence to volcanic action. In 1799 he paid his first visit to Vesuvius, which he did not again see till 1805, when he was accompanied by Humboldt and Gay-Lussac. They had the good fortune to witness a remarkable eruption, which supplied Buch with data for refuting many erroneous ideas then entertained regarding the activity of volcanoes. Three years before he had explored the south of France, and directed special attention to the extinct volcanoes of Auvergne. The aspect of the Puy de Dome, with its cone of trachyte and its strata of basaltic lava, induced him to abandon as untenable the doctrines of Werner on the formation of these rocks. The scientific results of his investigations he embodied in his *Geognostical Observations during Travels through Germany and Italy*, Berlin, 1802–9, 2 vols. 8vo. From the south of Europe Von Buch repaired to the north, and spent two years among the Scandinavian islands, making many important observations on the geography of plants, on climatology, and on geology. He also established the fact that the whole of Sweden is slowly but continuously rising above the level of the sea from Frederickshall to Abo. The details of these discoveries are given in his *Travels through Norway and Lapland*, Berlin, 1810. In 1815 he visited the Canary Islands in company with Christian Smith, the Norwegian botanist. His observations here convinced him that these and other islands of the Atlantic owed their existence to volcanic action of the most intense kind, and that the groups of islands in the South Sea are the remains of a pre-existing continent. The physical description of the Canary Islands was published at Berlin in 1825. After leaving the Canaries Von Buch proceeded to the Hebrides and the coasts of Scotland and Ireland. His geological excursions even into countries already repeatedly visited were continued without interruption till his 78th year. Eight months before his death, he visited the mountains of Auvergne; and on returning home he read a paper on the Jurassic Formation before the Academy of Berlin. The circumstances of Von Buch's life were singularly favourable to scientific pursuits. He inherited from his father a fortune more than sufficient for all his wants. He was never married, and was completely unembarrassed by family ties. His excursions he always undertook on foot, with a staff in his hand, and the large pockets of his over-coat filled with papers and geological instruments. Under this guise, the passer-by would not easily have recognized the man whom Humboldt pronounced the greatest geologist of his time. He died at Berlin on the 4th of March 1853. In addition to the works already mentioned Von Buch published others, of which we may specify the magnificent *Geological Map of Germany*, in 42 sheets, Berlin, 1832.

BUCHANAN, George (1506–1582), a celebrated Scottish historian and scholar, was born in February 1506. His father, a younger son of an old family, was the possessor of the farm of Moss, in the parish of Killearn, Stirlingshire, but he died at an early age, leaving his widow and children in poverty. George, the third son, is said to have attended Killearn school, but not much is known of his early education. In 1520 he was sent by his uncle to the university of Paris, where he prosecuted his studies with great ardour, and especially trained himself in poetical composition. In 1522 his uncle died, and Buchanan being thus unable to continue longer in Paris, returned to Scotland. After recovering from a severe illness, he joined the French auxiliaries who had been brought over by the duke of Albany, and took part in an unsuccessful inroad into England. In the following year he entered the university of St Andrews, where he graduated as B.A. in 1525. He had gone there chiefly for the purpose of attending the celebrated John Major or Mair's lectures on logic; and when that teacher removed to Paris Buchanan accompanied him. In 1527 he became B.A., and in 1528 M.A. at Paris. Next year he seems to have been appointed regent or professor in the college of Ste Barbe, and taught there for upwards of three years. In 1532 he became the friend and tutor of Gilbert Kennedy, earl of Cassilis, with whom he returned to Scotland about the beginning of 1537.

While residing at Paris Buchanan had been converted to the Protestant faith, and his first production in Scotland was the poem *Somnium*, attacking with keen satire the Franciscan friars and monastic life generally. This assault on the monks was not displeasing to James V., who engaged Buchanan as tutor to one of his natural sons, and encouraged him to a still more daring attack. Under these circumstances the *Franciscanus* was written, and it is not surprising that the author became an object of bitterest hatred to all of the Roman Catholic faith. Nor was it yet a safe matter to assail the church. In 1539 there was a bitter persecution of the Lutherans, and Buchanan among others was arrested. He managed to effect his escape, and with considerable difficulty made his way to London and thence to Paris. At Paris, however, he found his resolute enemy, Cardinal Beaton, and on the invitation of Andrew Govea, proceeded to Bordeaux. Govea was then principal of the newly-founded college of Guienne at Bordeaux, and by his exertions Buchanan was appointed professor of Latin. During his residence there several of his best works, the translations of *Medea* and *Alcestis*, and his two great dramas *Jephthes* and *Baptistes*, were completed.

After three years he returned to Paris, and in 1544 was appointed regent in the college of Cardinal le Moine, a post he held till 1547. He then accepted Govea's invitation to a chair in the new Portuguese university of Coimbra, afterwards one of the most celebrated seats of learning in Europe. But he had not been long in Portugal when Govea's death exposed him to the unwearied persecution of the priests. Buchanan was several times examined by the officers of the Inquisition, and finally was confined to a monastery, where he was condemned to hear edifying lessons from the monks. During his imprisonment, which lasted several months, he began his famous version of the Psalms. On his release he sailed for England, but soon made his way to Paris, where, in 1553, he was appointed regent in the College of Boncourt. He remained in that post for two years, and then accepted the office of tutor to the son of the Marshal de Brissac.

In 1560 or 1561 he returned to Scotland, and in April 1562 we find him installed as tutor to the young queen Mary, who was accustomed to read Livy with him daily. Buchanan now openly joined the Protestant or Reformed Church, and in 1566 was appointed by the earl of Murray principal of St Leonard's College, St Andrews. Two years before he had received from the queen the valuable gift of the revenue resulting from Crossraguel Abbey. He was thus in good circumstances, and his fame was steadily increasing. So great, indeed, was his reputation

for learning and administrative capacity that, though a layman, he was made moderator of the General Assembly in 1567. He had sat in the Assemblies from 1563.

The part Buchanan took in the affairs of Queen Mary is well known. He accompanied the Regent Murray into England, and his *Detection* (published in 1572) was produced to the commissioners at Westminster. In 1570, after the assassination of Murray, he was appointed one of the preceptors of the young king, and it was through his tuition that James acquired his great scholarship. Buchanan was a strict and severe master, and kept his pupil in salutary awe and obedience. James long remembered the feelings of dread with which he was accustomed to regard his formidable pedagogue.

While discharging the functions of royal tutor he also held other important offices. He was for a short time director of chancery, and then became lord privy seal, a post which entitled him to a seat in the Parliament. He appears to have continued in this office for some years, at least till 1579. He died on the 28th September 1582.

His last years had been occupied with two of his most important works. The first was the treatise *De Jure Regni apud Scotos*, published in 1579. In this famous work, composed in the form of a dialogue, and evidently intended to instil sound political principles into the mind of his pupil, Buchanan lays down the doctrine that the source of all political power is the people, that the king is bound by those conditions under which the supreme power was first committed to his hands, and that it is lawful to resist, even to punish, tyrants. A theory such as this was not likely to be palatable to James. The book was condemned in 1584, and again in 1664; while in 1683 it was burned by the loyal scholars of Oxford.

The second of his large works was the history of Scotland, *Rerum Scoticarum Historia*, completed shortly before his death and published in 1582. It is of great value for the period personally known to the author, which occupies the greater portion of the book. The earlier part is to a considerable extent based on the work of Boece and repeats the legendary history which was for so long an article of faith to every Scotchman.

Buchanan is the greatest scholar that Scotland has produced. For mastery over the Latin language he has never been surpassed by any modern writer. His style is not rigidly modelled upon that of any classical author, but has a certain freshness and elasticity of its own. He wrote Latin as if it had been his mother tongue. But in addition to this perfect command over the instrument of expression, Buchanan had a rich vein of poetical feeling, and great powers of thought. His translations of the Psalms and of the Greek plays are more than mere versions; they have a peculiar grace and felicity. The smaller satirical poems are masterpieces of wit and expressive language, while the two tragedies, *Baptistes* and *Jephthes*, are works whose merits have not perhaps been generally recognized.

There are two complete editions of Buchanan's works, one by Ruddiman, 2 vols. fo., 1715; the other by Burman, 2 vols. 4to, 1725. His life has been written by Dr Irving, *Memoirs of the Life and Writings of George Buchanan*, 2d edition, 1817. The *Jephthah* and *Baptist* have been translated by A. Gibbs, 1870.

BUCHANAN, JAMES (1791–1868), fifteenth President of the United States, was born in Franklin County, Pennsylvania. His father, of the same name, was an Irishman who had eight years before emigrated from Donegal, and had become a well-to-do farmer. The son completed his education at Dickinson College, Carlisle, and took his degree in 1809. He then applied himself to the study of the law, was admitted to the bar in 1812, and settled at Lancaster in Pennsylvania. Notwithstanding his youth he soon gained considerable reputation, and with it a large and growing practice. In 1812 he joined a party of volunteers who, under the command of Judge Shippen, marched to the defence of Baltimore against the British; but their services were not wanted. He was at this time a zealous federalist. In 1814 he was elected member of the State Legislature, and constantly recommended the vigorous prosecution of the war. He was re-elected the following year; and in 1820 he became a member of Congress. Among his important early speeches were those on a deficiency in the military appropriation, in January 1822; on the bankrupt law, in March following, when he successfully opposed its extension to all citizens whether traders or not; and on the tariff question, on which he maintained that duties ought to be levied for revenue only. He uttered grave warnings against forming alliances with Mexico and the South American Republics, the condition of which was not calculated to inspire hopefulness, and insisted on the immense importance of Cuba, both commercially and strategically, to the United States. In 1828 he supported General Jackson at the Presidential election, and was at the same time re-elected to Congress. In the following year he succeeded Daniel Webster as head of the judiciary committee, and in this capacity conducted the trial on impeachment of Judge Peck,—one of the *causes célèbres* of American jurisprudence. On completing his fifth term, Buchanan retired from Congress (1831), and the next year was appointed envoy extraordinary and minister plenipotentiary to St Petersburg. His mission is marked by the negotiation of the first treaty of commerce between the United States and Russia,—a treaty by which important privileges in the Baltic and the Black Sea were secured to the former. On his return from Russia he was elected United States senator; and he retained his seat till 1845. In the great struggle between President Jackson and the party headed by Mr Calhoun, Buchanan warmly defended the president and his claims. In the first years of the movement against slavery, he saw the large results which were likely to follow, and desired to suppress the agitation in its infancy, and this by suppressing the discussion of the subject in Congress. He advocated the recognition by Congress of the independence of Texas, and at a later time its annexation. During the presidency of Van Buren, Buchanan greatly distinguished himself in support of the principal measure of the Government—the establishment of an independent treasury. In 1845 he was appointed Secretary of State under President Polk; and at the close of his term of office in 1849 he retired into private life. But four years later he accepted from President Pierce the post of United States Minister to Great Britain. In 1854 he was the originator and one of the three members of the Ostend Conference on the subject of the acquisition of Cuba by the United States, and with his colleagues maintained that, on the principle of self-preservation from dangers of the gravest kind, an armed intervention of the United States and the capture of the island from the Spaniards would be justifiable. He returned from England in 1856, and the same year was elected, as Democratic candidate, to the Presidential chair. For a short time there seemed to be ground for hope that political passions and excitement would subside. But this hope was soon found to be fallacious. The troubles in Kansas and the large questions involved in them gave rise to new discussions and division. The president gave his support to the pro-slavery party, and dissensions grew during his administration to such an extent that disruption and war between North and South followed the election of his successor, President Lincoln. From the close of his administration in 1860 till his death, Buchanan led a retired life. He died at Wheatland in Pennsylvania, June 1, 1868. Two years before his death he published an account of his administration.

fellow-students there being the illustrious Alexander Von Humboldt. At the age of twenty-three he published his *Attempt at a Mineralogical Description of Landeck*, and also an *Attempt at a Geognostic Description of Silesia*. He was at this time a zealous upholder of the Neptunian theory of his illustrious master. In 1797 he met his old school-fellow Von Humboldt at Salzburg, and with him explored the geological formations of Styria and the adjoining Alps. In the spring of the following year, Von Buch extended his excursions into Italy, where his faith in the Neptunian theory was for the first time shaken. In his previous works he had advocated the aqueous origin of basaltic and other formations; he was now not less clearly convinced that these owed their existence to volcanic action. In 1799 he paid his first visit to Vesuvius, which he did not again see till 1805, when he was accompanied by Humboldt and Gay-Lussac. They had the good fortune to witness a remarkable eruption, which supplied Buch with data for refuting many erroneous ideas then entertained regarding the activity of volcanoes. Three years before he had explored the south of France, and directed special attention to the extinct volcanoes of Auvergne. The aspect of the Puy de Dome, with its cone of trachyte and its strata of basaltic lava, induced him to abandon as untenable the doctrines of Werner on the formation of these rocks. The scientific results of his investigations he embodied in his *Geognostical Observations during Travels through Germany and Italy*, Berlin, 1802–9, 2 vols. 8vo. From the south of Europe Von Buch repaired to the north, and spent two years among the Scandinavian islands, making many important observations on the geography of plants, on climatology, and on geology. He also established the fact that the whole of Sweden is slowly but continuously rising above the level of the sea from Frederickshall to Abo. The details of these discoveries are given in his *Travels through Norway and Lapland*, Berlin, 1810. In 1815 he visited the Canary Islands in company with Christian Smith, the Norwegian botanist. His observations here convinced him that these and other islands of the Atlantic owed their existence to volcanic action of the most intense kind, and that the groups of islands in the South Sea are the remains of a pre-existing continent. The physical description of the Canary Islands was published at Berlin in 1825. After leaving the Canaries Von Buch proceeded to the Hebrides and the coasts of Scotland and Ireland. His geological excursions even into countries already repeatedly visited were continued without interruption till his 78th year. Eight months before his death, he visited the mountains of Auvergne; and on returning home he read a paper on the Jurassic Formation before the Academy of Berlin. The circumstances of Von Buch's life were singularly favourable to scientific pursuits. He inherited from his father a fortune more than sufficient for all his wants. He was never married, and was completely unembarrassed by family ties. His excursions he always undertook on foot, with a staff in his hand, and the large pockets of his over-coat filled with papers and geological instruments. Under this guise, the passer-by would not easily have recognized the man whom Humboldt pronounced the greatest geologist of his time. He died at Berlin on the 4th of March 1853. In addition to the works already mentioned Von Buch published others, of which we may specify the magnificent *Geological Map of Germany*, in 42 sheets, Berlin, 1832.

BUCHANAN, George (1506–1582), a celebrated Scottish historian and scholar, was born in February 1506. His father, a younger son of an old family, was the possessor of the farm of Moss, in the parish of Killearn, Stirlingshire, but he died at an early age, leaving his widow and children in poverty. George, the third son, is said to have attended Killearn school, but not much is known of his early education. In 1520 he was sent by his uncle to the university of Paris, where he prosecuted his studies with great ardour, and especially trained himself in poetical composition. In 1522 his uncle died, and Buchanan being thus unable to continue longer in Paris, returned to Scotland. After recovering from a severe illness, he joined the French auxiliaries who had been brought over by the duke of Albany, and took part in an unsuccessful inroad into England. In the following year he entered the university of St Andrews, where he graduated as B.A. in 1525. He had gone there chiefly for the purpose of attending the celebrated John Major or Mair's lectures on logic; and when that teacher removed to Paris Buchanan accompanied him. In 1527 he became B.A., and in 1528 M.A. at Paris. Next year he seems to have been appointed regent or professor in the college of Ste Barbe, and taught there for upwards of three years. In 1532 he became the friend and tutor of Gilbert Kennedy, earl of Cassilis, with whom he returned to Scotland about the beginning of 1537.

While residing at Paris Buchanan had been converted to the Protestant faith, and his first production in Scotland was the poem *Somnium*, attacking with keen satire the Franciscan friars and monastic life generally. This assault on the monks was not displeasing to James V., who engaged Buchanan as tutor to one of his natural sons, and encouraged him to a still more daring attack. Under these circumstances the *Franciscanus* was written, and it is not surprising that the author became an object of bitterest hatred to all of the Roman Catholic faith. Nor was it yet a safe matter to assail the church. In 1539 there was a bitter persecution of the Lutherans, and Buchanan among others was arrested. He managed to effect his escape, and with considerable difficulty made his way to London and thence to Paris. At Paris, however, he found his resolute enemy, Cardinal Beaton, and on the invitation of Andrew Govea, proceeded to Bordeaux. Govea was then principal of the newly-founded college of Guienne at Bordeaux, and by his exertions Buchanan was appointed professor of Latin. During his residence there several of his best works, the translations of *Medea* and *Alcestis*, and his two great dramas *Jephthes* and *Baptistes*, were completed.

After three years he returned to Paris, and in 1544 was appointed regent in the college of Cardinal le Moine, a post he held till 1547. He then accepted Govea's invitation to a chair in the new Portuguese university of Coimbra, afterwards one of the most celebrated seats of learning in Europe. But he had not been long in Portugal when Govea's death exposed him to the unwearied persecution of the priests. Buchanan was several times examined by the officers of the Inquisition, and finally was confined to a monastery, where he was condemned to hear edifying lessons from the monks. During his imprisonment, which lasted several months, he began his famous version of the Psalms. On his release he sailed for England, but soon made his way to Paris, where, in 1553, he was appointed regent in the College of Boncourt. He remained in that post for two years, and then accepted the office of tutor to the son of the Marshal de Brissac.

In 1560 or 1561 he returned to Scotland, and in April 1562 we find him installed as tutor to the young queen Mary, who was accustomed to read Livy with him daily. Buchanan now openly joined the Protestant or Reformed Church, and in 1566 was appointed by the earl of Murray principal of St Leonard's College, St Andrews. Two years before he had received from the queen the valuable gift of the revenue resulting from Crossraguel Abbey. He was thus in good circumstances, and his fame was steadily increasing. So great, indeed, was his reputation

BUCHAREST, Bukhorest, Bukorest, or, as it is called by the inhabitants, Bucuresci (that is, according to their own etymology, City of Joy), is the capital of Roumania, the residence of the prince and the seat of a bishop. It is situated in a hollow on the River Dimbovitza, a tributary of the Danube, in 44° 25′ 30″ N. lat. and 26° 5′ 24″ E. long., and occupies an area of more than 20 English square miles. The number of its cupolas and minarets, and the profusion of acacia, poplar, and other trees that fill the numerous spaces of unoccupied ground, give it a picturesque appearance from a distance. The arrangement of its streets is very irregular, and in many districts it cannot be said that there are streets at all. In general the roadways are either unpaved or only laid with rough blocks of different sizes. A few streets, indeed (and notably the Podo Mogochoi, which is the most important), have been paved with Aberdeen granite. The city is lighted with gas produced from English coal; and a considerable but far from satisfactory supply of water is obtained from the river and distributed partly by water-carts and partly by iron pipes. Of the public buildings few are of much architectural importance; the national theatre is one of the largest, and the "academy" one of the finest. The latter is occupied by the university, a library of 26,000 volumes, a public museum of antiquities and natural history, and a large theatre, which is used by the senate during the parliamentary session. The palace, an insignificant building, was founded by the Golesco family in the 18th century. There are 116 Greek churches in the city, of which the most remarkable are the Metropolitan, St George, St Spiridion, and Sarindar. The Roman Catholics have a parish-church in the centre of the town and several chapels; there are Lutheran and Calvinistic churches, with schools attached for both boys and girls; and the Jews, who number about 15,000, have ten synagogues. There are about a score of conventual establishments, the majority belonging to the Greek Church. The Brancovano hospital, founded by the family of that name, has accommodation for between 200 and 300 patients, the military hospital for 300, the Culza for 200, the Philanthropic for 100, and the Pantelemonu for 120. The Marcutza insane asylum can receive 220; and the Helena asylum, founded by the Princess Helena in 1862, has room for 220 orphan girls. There is also a children's hospital for 100 patients, and a lying-in hospital for 40. In Bucharest there is always a numerous garrison, and the arsenal and barracks on the plateau of Dealu and the cavalry and infantry barracks at St George are both extensive establishments. Cafés and coffee-gardens abound, and are allowed to remain open all night. There are two public gardens, the Cismegiu in the centre of the town, about a mile in circumference, and the Kisilev on the outskirts, which is traversed by the fashionable promenade known as the Chaussée. Public locomotion is facilitated by about 500 droshkas in summer and as many sledges in winter; and a tramway has recently been laid down by an English company. The monetary business of the city is extensive,—its principal establishments being the Bank of po- Roumania, founded in 1865, with a capital of one million instr-sterling, and the *Société Financière de Roumanie*, with a easily -pital of six million francs. The manufacturing industry nounced -ght, the principal article being Turkish cloth; but the Berlin on -oth in foreign and native goods is of very considerable works alrea- The mercantile portion of the community is largely which we m-l of foreigners—Germans, Greeks, Frenchmen, *Germany*, in -who keep themselves very much apart from each

BUCHAN-Division into classes and nationalities is a marked Scottish his-of the whole Bucharest population. The Boyards, His father, -their aristocratic pretensions are no longer recognized of the farm, are as exclusive as ever. There are about 20,000 shire, but he -uias -who fill subordinate positions; the droshka-children in poverty. Geo-

drivers are mainly Russians of the Lipovani sect; and Bulgarians, Armenians, gypsies, and many others swell the motley multitude. In spite of the fact that the number of deaths is frequently in excess of the number of births, the increase of the population is rapid, and house-rents have become very high; and that it is more the habits of the people than the unhealthiness of the city that is to blame for the death-rate is shown by the steady internal increase of the Jewish community. About eighteen newspapers are published in the city—three daily and the others twice or thrice a week. The railway system, begun by the opening of the line to Giurgevo on the Danube in 1869, is rapidly extending, and there is direct communication with Western Europe by the line to Lemberg. The population, which was 121,754 in 1859, had increased by 1870 to 200,000, and is now stated at 251,000.

Bucharest owes its foundation in the 13th century to Radel the Black of Wallachia. Burnt in 1595 by Sinan Pasha it was soon afterwards restored, but it was not till the 18th century that it appeared much in European history. It was frequently of importance in the contests for the neighbouring provinces, which so often broke out between the Turks and their northern rivals Austria and Russia; and in 1812 it gave its name to the treaty by which Bessarabia and a third of Moldavia were ceded to the latter power. In the war of 1828 it was occupied by the Russians, who made it over to the prince of Wallachia in the following year. A rebellion against Prince Bibesko in 1848 brought both Turkish and Russian interference, and the city was again held by Russian troops from 1853 to 1854. On their departure an Austrian garrison took possession and remained till March 1857. In 1858 the international congress for the organization of the Danubian principalities was held in the city; and in 1861 the union of Wallachia and Moldavia was proclaimed. Prince Couza, the first ruler of the united provinces, was driven from his throne by an insurrection in Bucharest in 1866.

BUCHEZ, Philippe Joseph Benjamin (1796–1865), French author and politician, was born at Matagne-la-Petite, in the department of the Ardennes. He finished his general education in Paris, and afterwards applied himself to the study of natural science and medicine. Hatred of the Government of the Restoration, and enthusiasm for democratic ideas, were at that time widely diffused among the young men of the schools of Paris, and these passions gained full possession of the mind of Buchez. With his friends Bazard and Flotard he founded, in 1821, a secret association—a system of French carbonarism—which spread rapidly and widely, and displayed itself in repeated attempts at revolution. In one of these attempts—the affair at Belfort—which cost General Berton, Colonel Caron, and four soldiers of Rochelle their lives, he was gravely compromised, although the jury which tried him did not find the evidence sufficient to warrant his condemnation. In 1825 he graduated in medicine, and soon after he published, along with M. Trelat, a *Précis élémentaire d'Hygiène*. About the same time he became a member of the Saint-Simonian Society, presided over by Bazard, Enfantin, and Rodriguez, and contributed to its organ, the *Producteur*. He left it in consequence of aversion to the strange theological dogmas of its spiritual chief, M. Enfantin, and began to elaborate what he regarded as a Christian socialism. For the exposition and advocacy of his principles he founded a periodical called *L'Européen*. In 1833 he published an *Introduction à la Science de l'Histoire*, which was received with considerable favour, and of which a second edition, improved and enlarged, in two volumes, appeared in 1842. Notwithstanding its prolixity and discursiveness, this is both an interesting and a meritorious work. The part of it which treats of the aim ... methods of the science

of history is truly valuable. On the other hand, what is most distinctive in M. Buchez's theory—the division of historical development into four great epochs originated by four universal revelations, of each epoch into three periods corresponding to desire, reasoning, and performance, and of each of these periods into a theoretical and practical age—seems entitled to no higher commendation than that of being ingenious. (See Flint's *Philosophy of History in Europe*, i., 242–252). M. Buchez next edited, along with M. Roux Laverne, the *Histoire parlementaire de la Révolution Française* (1833–38, 40 vols). This vast, laborious, conscientious publication is one of the chief sources of information regarding the early periods of the first French Revolution. There is a review of it by Mr Carlyle (*Miscellanies*), the first two parts of whose own history of the French Revolution are mainly drawn from it. The editors worked under the inspiration of a strong admiration of the principles of Robespierre and the Jacobins, and in the belief that the French Revolution was an attempt to realize Christianity.

M. Buchez gave a general exposition of his views in his *Essai d'un Traité complet de Philosophie au point de vue du Catholicisme et du progrès* (3 vols. 1839–40). Perhaps the fundamental doctrine of this treatise is that the primitive, intellectual, moral, and religious ideas of men cannot be adequately explained as innate, or as derived from sensation, sentiment, or reasoning, but must have been imparted by divine revelation. It is substantially identical with the fundamental doctrine of De Bonald, although Buchez infers from it democratic instead of theocratic consequences. Great prominence is given to the conception of progress which is attained by generalization from a comprehensive survey of geology, physiology, and history. The author sets very distinctly before himself also the aim of organizing the sciences into a single comprehensive system. This he thought could only be accomplished through an *a priori* synthetic method, and not, as had previously been attempted, by the analytical and experimental method. It was partly owing to the reputation which he had acquired by these publications, but still more owing to his connection with the *National* newspaper, and with the secret societies hostile to the Government of Louis Philippe, that he was raised, by the Revolution of 1848, to the presidency of the Constituent Assembly. He speedily showed that he was not possessed of the firmness, decision, and political capacity needed in a situation so difficult and in days so tempestuous. He retained the position only for a very short time. After the dissolution of the Assembly he was not re-elected. Thrown back into private life, he resumed his studies, and added several works to those which have been already mentioned. A *Traité de Politique*, which may be considered as the completion of his *Traité de Philosophie*, is the most important of the productions of the last period of his life. His brochures are very numerous and on a great variety of subjects, medical, historical, political, philosophical, &c. He died in 1865. He found a disciple of considerable ability in M. Ott, who has advocated and applied his principles in various writings, the most recent of which, perhaps, places the metaphysical theory of Buchez in as favourable a light as it can be seen under. (R. F.)

BUCHU or BUKA LEAVES are the produce of several shrubby plants belonging to the genus *Barosma* (Nat. Order, *Rutaceæ*), natives of the Cape of Good Hope. The principal species, *B. crenulata*, has leaves of a smooth leathery texture, oblongo-ovate in shape, from an inch to an inch and a half in length, with serrulate or crenulate margins, on which as well as on the under side are conspicuous oil cells. The other species which yield buchu are *B. serratifolia*, having linear-lanceolate sharply serrulate leaves, and *B. betulina*, the leaves of which are cuneate obovate, with denticulate margins. They are all, as found in commerce, of a pale yellow-green colour; they emit a peculiar aromatic odour, and have a slightly astringent bitter taste. Buchu leaves contain a volatile oil, to which evidently their therapeutic influence is due, and are said to yield a bitter extractive principle, which has received the name of diosmin. The leaves of a closely allied plant, *Empleurum serratulum*, are employed as a substitute or adulterant for buchu. Buchu leaves are chiefly used in European pharmacy in inflammatory disorders of the bladder and urinary organs; in the United States they are much employed by vendors of secret medicines. An infusion of the leaves is tonic, sudorific, and diuretic. At the Cape buchu has great reputation in gout and rheumatism, and as a stomachic stimulant; and in the form of buchu brandy and buchu vinegar it is applied as an embrocation in sprains, contusions, and rheumatic pains.

BÜCKEBURG, the capital of the principality of Schaumburg-Lippe, is situated at the foot of the Harrlberg on the River Aue, about 6 miles from Minden, on the Minden and Hanover Railway. It has a castle surrounded by a park, a gymnasium, a normal seminary, a library, an orphanage, a synagogue, and three churches, one of which has the appropriate inscription, *Religionis non structuræ exemplum*. The first houses of Bückeburg began to gather round the castle about 1365; and it was not till the 17th century that the town was surrounded with walls. Population in 1871, 4686.

BUCKINGHAM, COUNTY OF, BUCKINGHAMSHIRE, or BUCKS, an inland county of England, between 51° 25′ and 52° 10′ N. lat., and 0° 28′ and 1° 12′ W. long., is bounded N. by Northamptonshire W. by Oxfordshire, S. by Berkshire, and E. by Bedfordshire, Hertfordshire, and Middlesex. It is the thirty-third in size of the English counties, measuring 53 miles at its greatest length and 27 at its greatest breadth, and containing, according to the last ordnance survey, 467,009 acres, or nearly 730 square miles. The aspect of the country is agreeably diversified by the distribution of forests, rivers, hills, pasture, and arable land. In the southern portion of the county the forests, consisting chiefly of beeches (from the Saxon name of which tree, *boc*, the county is said to derive its name), were at one time very extensive, but have of late years been greatly thinned; woods of considerable extent are still to be found in the northern parts. The principal rivers of Buckinghamshire are the Thames, which separates

For map see OXFORD.

site of the old castle, has a handsome spire, 150 feet high, and has been restored and extended under the direction of Sir G. G. Scott, who was born in the neighbourhood. There are also a jail, a union workhouse, and several dissenting churches. An endowed free school for boys, who were clad in green coats by the will of the founder, Gabriel Newton, is now incorporated with the national school, which is intended to accommodate 300 pupils. The grammar-school of the town was founded by Edward VI., and occupies the chapel of the guild of the Holy Trinity, founded by Archdeacon Stratton in 1268. The manufactures, which include bone-grinding, malt-making, and tanning, are of comparatively small importance. Lace-making with bobbins still occupies a small part of the female population. There are also some corn-mills in the neighbourhood, and a few lime quarries. The borough of Buckingham formerly returned two members to Parliament, but since 1868 it has only returned one. It is governed by a mayor, four aldermen, and twelve councillors. Population of parliamentary borough in 1871, 7545; of municipal borough, 3703. Buckingham is a town of great antiquity. It was fortified with earthen ramparts by Edward the Elder in 918, and in 1010 it was captured by the Danes. It is mentioned as an ancient borough in *Domesday Book*, but does not seem to have returned members to Parliament till the reign of Henry VIII. In the reign of Edward III it was a wool-staple, but not long after its prosperity began to decline. From Queen Mary it received a charter in 1554. It was the headquarters of Charles I. for a few days during his war with the Parliament. In 1725 a third part of the town was burnt to the ground.

BUCKINGHAM, GEORGE VILLIERS, DUKE OF (1592–1628), born August 20, 1592, was a younger son of Sir George Villiers of Brooksby. His mother, who was left a widow early, educated him for a courtier's life, and the lad, being by nature little studious and contemplative, took kindly to the training. He could dance well, fence well, and talk a little French, when in August 1614 he was brought before the king's notice, in the hope that he would take a fancy to him.

The moment was favourable Since Salisbury's death James had taken the business of government upon himself. But he wanted some one who would chat with him, and amuse him, and would also fill the office of private secretary, and save him from the trouble of saying No to importunate suitors. It would be an additional satisfaction if he could train the youth whom he might select in those arts of statesmanship of which he believed himself to be a perfect master. His first choice had not proved a happy one. Robert Carr, who had lately become earl of Somerset, had had his head turned by his elevation. He had grown peevish toward his master, and had placed himself at the head of the party which was working for a close alliance with Spain.

The appearance of Villiers, beaming with animal spirits and good humour, was therefore welcomed by all who had an interest in opposing the designs of Spain. With such powerful backing Villiers prospered at court, became a gentleman of the bed-chamber, was knighted, and received a pension of £1000 a year. For some little time, however, Somerset's pre-eminence was maintained. But the charge of murder brought against him completed his ruin, and Villiers at once stepped into the place which he had vacated. In August 1616 he was raised to the peerage as Viscount Villiers. In January 1617 he became earl of Buckingham. In January 1618 he was a marquis by the same title. Estates to the value of some £15,000 a year were settled on him. With the exception of the earl of Pembroke he was the richest nobleman in England.

Those who expected him to give his support to the anti-Spanish party were at first doomed to disappointment. As yet he was no politician, and he contented himself with carrying out his master's orders, whatever they were. In his personal relations he was kindly and jovial towards all who did not thwart his wishes. But James had taught him to consider that the patronage of England was in his hands, and he took good care that no man should receive promotion of any kind who did not in one way or another pay court to him. As far as can be ascertained, he cared less for money than for the gratification of his vanity. But he had not merely himself to consider. His numerous kinsfolk were to be enriched by marriage, if in no other way, and Bacon, the great philosopher and statesman, was all but thrust from office, because he had opposed a marriage suggested for one of Buckingham's brothers, whilst Cranfield, the first financier of the day, was kept from the Treasury till he would forsake the woman whom he loved, to marry a penniless cousin of the favourite.

In the meanwhile Buckingham had found an appropriate position in the mastership of the horse, which gave him control over the royal stables. In January 1619 James made him lord high admiral of England, hoping that the ardent, energetic youth would impart something of his own fire to those who were intrusted with the oversight of that fleet which had been almost ruined by the peculation and carelessness of the officials. Something of this, no doubt, was realized under Buckingham's eye. But he himself never pretended to the virtues of an administrator, and he was too ready to fill up appointments with men who flattered him, and too reluctant to dismiss them, if they served their country ill, to effect any permanent change for the better.

It was about this time that he first took an independent part in politics. All England was talking of the revolution in Bohemia in the year before, and men's sympathy with the Continental Protestants was increased when it was known that James's son-in-law had accepted the crown of Bohemia, and that in the summer of 1620 a Spanish force was preparing to invade the Palatinate. Buckingham at first had thrown himself into the popular movement. Before the summer of 1620 was at end he had swung round, and was in close agreement with Gondomar, the Spanish ambassador. He had now married Lady Catherine Manners, the daughter of the earl of Rutland, who was at heart a Roman Catholic, though she outwardly conformed to the English Church, and this alliance may have had something to do with the change.

Buckingham's mistakes were owing mainly to his levity. If he passed briskly from one camp to the other, an impartial observer might usually detect some personal motive at the bottom. But it is hardly probable that he was himself conscious of anything of the sort. When he was in reality acting under the influence of vanity or passion it was easy for him to persuade himself that he was doing his duty to his country.

The Parliament which met in 1621 broke out into a loud outcry against the system of monopolies, from which Buckingham's brothers and dependants had drawn a profit, which was believed to be greater than it really was. At first he pleaded for a dissolution. But he was persuaded that it would be a wiser course to offer to put himself at the head of the movement, and when he came forward to say that he would rather sacrifice his brother than countenance wrong doing, he only gave utterance to those sentiments of patriotism which he really felt, when patriotism did not call upon him to sacrifice his own wishes. When, at a later period of the session, Bacon's case was brought forward, he made no attempt to meet the attack directly, but he did his best to shield the falling chancellor from the extreme penalties demanded by his adversaries. It was not long before he showed on how shallow a basis impulsive generosity rests. Bacon clung, after his fall, to the [illegible] of

provisions, and without money to buy them, the wretched troops sickened and died in the winter frosts. Buckingham's first military enterprise ended in disastrous failure.

Buckingham had many other schemes in his teeming brain. He had offered to send aid to Christian IV., king of Denmark, who was proposing to make war in Germany, and had also a plan for sending an English fleet to attack Genoa the ally of Spain, and a plan for sending an English fleet to attack Spain itself.

Before these schemes could be carried into operation James died on March 27, 1625. The new king and Buckingham were at one in their aims and objects. Both were anxious to distinguish themselves by the chastisement of Spain, and the recovery of the Palatinate. Both were young and inexperienced. But Charles, obstinate when his mind was made up, was sluggish in action and without fertility in ideas, and he had long submitted his mind to the versatile and brilliant favourite, who was never at a loss what to do next, and who unrolled before his eyes visions of endless possibilities in the future. Buckingham was sent over to Paris to urge upon the French Court the importance of converting its alliance into active co-operation.

There was a difficulty in the way. The Huguenots of Rochelle were in rebellion, and James had promised the aid of English ships to suppress that rebellion. Buckingham, who seems at first to have consented to the scheme, was anxious to mediate peace between the king of France and his subjects, which would set him free from foreign enterprises, and save Charles from compromising himself with his Parliament by the appearance of English ships in an attack upon Protestants. When he returned his main demands were refused, but hopes were given him that peace would be made with the Huguenots. On his way through France he had the insolence to make love to the Queen of France. Unless the testimony of his warmest admirers is false, he had convinced himself by a sad experience that women found it difficult to resist his seductive tongue and his handsome face.

Soon after his return Parliament was opened. It would have been hard for Charles to pass through the session with credit. Under Buckingham's guidance he had entered into engagements involving an enormous expenditure, and these engagements involved a war on the Continent, which had never been popular in the House of Commons. The Commons, too, suspected the marriage treaty contained engagements of which they disapproved. They asked for the full execution of the laws against the Catholics, and voted but little money in return. Charles adjourned then to Oxford, that he might plead with them more persuasively. Before they met there, the English ships had found their way into the hands of the French, to be used against Rochelle. The Commons met in an ill-humour. They had no confidence in Buckingham, and they asked that persons whom they could trust should be admitted to the king's council before they would vote a penny. Charles stood by his minister, and on August 12 he dissolved his first Parliament.

Buckingham and his master set themselves to work to conquer public opinion. On the one hand, they threw over their engagements to France on behalf of the English Catholics. On the other hand they sent out a large fleet to attack Cadiz, and to seize the Spanish treasure-ships. Buckingham went to the Hague to raise an immediate supply by pawning the crown jewels, to place England at the head of a great Protestant alliance, and to enter into fresh obligations to furnish money to the king of Denmark. It all ended in failure. The fleet returned from Cadiz having effected nothing. The crown jewels produced but a small sum, and the money for the king of Denmark could only be raised by an appeal to Parliament. In the meanwhile the king of France was deeply offended by the treat-

ment of the Catholics, and by the seizure of French vessels on the ground that they were engaged in carrying goods for Spain.

When Charles's second Parliament met on February 6, 1626, it was not long before, under Eliot's guidance, it asked for Buckingham's punishment. He was impeached before the House of Lords on a long string of charges. Many of these charges were exaggerated, and some were untrue. But as long as Charles refused to listen to the complaints of his minister's incompetency, the only way in which the Commons could reach him was by bringing criminal charges against him. Charles dissolved his second Parliament as he had dissolved his first.

To find money was the great difficulty. Recourse was had to a forced loan, and men were thrown into prison for refusing to pay it. There had been disasters to Charles's allies in Germany, and a French war was impending in addition to the Spanish one. The French were roused to reprisals by Charles's persistence in seizing French vessels. Unwilling to leave Rochelle open to the entrance of an English fleet, Richelieu laid siege to that stronghold of the French Huguenots. On June 27, 1627, Buckingham sailed from Portsmouth at the head of a numerous fleet, and a considerable land force, to relieve the besieged city.

His first enterprise was the siege of the fort of St Martin's, on the Isle of Rhé. The ground was hard, and the siege operations were converted into a blockade. On September 27, the defenders of the fort announced their readiness to surrender the next morning. In the night a fresh gale brought over a flotilla of French provision boats, which dashed through the English blockading squadron. The fort was provisioned for two months more. Buckingham resolved to struggle on, and sent for reinforcements from England. Charles would gladly have answered to his call. But England had long since ceased to care for the war. There was no money in the exchequer, no enthusiasm in the nation to supply the want. Before the reinforcements could arrive the French had thrown a superior force upon the island, and Buckingham was driven to retreat with heavy loss.

His spirits were as buoyant as ever. Ill luck, or the misconduct of others, was the cause of his failure. He had new plans for carrying on the war. But the Parliament which met on March 17, 1628, was resolved to exact from the king an obligation to refrain from encroaching for the future on the liberties of his subjects.

In the parliamentary battle, which ended in the concession of the Petition of Right, Buckingham took an active share as a member of the House of Lords. He resisted as long as it was possible to resist the demand of the Commons, that the king should abandon his claim to imprison without showing cause. When the first unsatisfactory answer to the petition was made by the king on June 2, the Commons suspected, probably with truth, that it had been dictated by Buckingham. They prepared a remonstrance on the state of the nation, and Coke at last named the duke as the cause of all the misfortunes that had occurred. Though on June 7 the king granted a satisfactory answer to the petition, the Commons proceeded with their remonstrance, and on June 11 they informed the king that Buckingham had "so abused his powers," that it was no longer safe to continue him in office.

Once more Charles refused to surrender Buckingham, and a few days later he prorogued Parliament in anger. The popular feeling was greatly excited. Lampoons circulated freely from hand to hand, and Dr Lambe, a quack doctor, who dabbled in astrology, and was believed to exercise influence over Buckingham, was murdered in the streets of London. Rude doggerel lines announced that the duke should share the doctor's fate.

With the clouds gathering round him, Buckingham went down to Portsmouth to take the command of one final expedition for the relief of Rochelle. For the first time even he was beginning to acknowledge that he had undertaken a task beyond his powers. There was a force of inertia in the officials which resisted his efforts to spur them on to an enterprise which they believed to be doomed to failure. He entered gladly into a scheme of pacification proposed by the Venetian ambassador. But before he could know whether there was to be peace or war, the knife of an assassin put an end to his career. John Felton, who had served at Rhé, had been disappointed of promotion, and had not been paid that which was due to him for his services, read the declaration of the Commons that Buckingham was a public enemy, and eagerly caught at the excuse for revenging his private wrongs under cover of those of his country. Waiting, on the morning of August 23, beside the door of the room in which Buckingham was breakfasting, he stabbed him to the heart as he came out. The man who for four years had been practically the ruler of England fell dead upon the ground. He had only completed his thirty-sixth year three days before. (S. R. G.)

BUCKINGHAM, GEORGE VILLIERS, SECOND DUKE OF (1627–1688), was born at London January 30, 1627, about a year and a half before the murder of his father. He was educated at Cambridge, returned from a Continental tour on the outbreak of the civil war, and at once threw in his lot with the king. The detachment in which he held a command was defeated at Nonsuch, and he with difficulty effected an escape from England. His estates were confiscated by Parliament, and part of them were bestowed upon Fairfax. He returned with Charles II. and took part in the battle of Worcester, after which he again fled. About 1657 he returned secretly to England and married one of Fairfax's daughters. Arrested by order of Cromwell, he was thrown into the Tower and kept in confinement for some time. After the Restoration he recovered his estates, and rose to high favour with Charles II. He was a man of great talent, but utterly without principle, versatile and whimsical to the last degree.

> "A man so various that he seemed to be
> Not one, but all mankind's epitome."

He was a profligate and a statesman, a musician, an alchemist, a writer of farces, and a courtier,—"everything by starts, and nothing long." He was radically fickle, and could not be faithful to any party. In 1671 his power was at its height. He had done much to bring about the dismissal of Clarendon, had formed the famous council called the Cabal, and was in fact prime minister of England. But the measures he and his associates passed were little calculated to allay the strong popular feeling against the Government. The Cabal was quickly dissolved, and Buckingham, with his usual versatility, at once became an ardent friend of the democratic leaders. Soon afterwards he seems to have been disgusted with politics, and gradually withdrew from court. After the death of Charles he retired to his seat at Helmsley in Yorkshire, and devoted himself to hunting and other country amusements. He died on the 17th April 1688, in the house of one of his tenants, having been seized with a fever produced by sitting on the damp ground after being heated with riding. He was buried in Westminster Abbey. Buckingham was the author of some farces, comedies, and miscellaneous poems, but he is chiefly remembered in English literature by the *Rehearsal*, a clever parody upon Dryden and other stilted tragedians. His works were collected in 1704.

BUCKINGHAMSHIRE, JOHN SHEFFIELD, DUKE OF (1649–1721), was the son of Edmund, second earl of Mulgrave, and succeeded to that title on his father's death in 1658. At the age of seventeen he joined the fleet in

the external world are sublime and terrible, the understanding being emboldened and the imagination curbed when they are small and feeble; 4. That the great division between European and non-European civilization turns on the fact that in Europe man is stronger than nature, and that elsewhere nature is stronger than man, the consequence of which is that in Europe alone has man subdued nature to his service; 5. That the advance of European civilization is characterized by a continually diminishing influence of physical laws, and a continually increasing influence of mental laws; 6. That the mental laws which regulate the progress of society cannot be discovered by the metaphysical method, that is, by the introspective study of the individual mind, but only by such a comprehensive survey of facts as will enable us to eliminate disturbances, that is, by the method of averages; 7. That human progress has been due, not to moral agencies, which are stationary, and which balance one another in such a manner that their influence is unfelt over any long period, but to intellectual activity, which has been constantly varying and advancing:—"The actions of individuals are greatly affected by their moral feelings and passions; but these being antagonistic, to the passions and feelings of other individuals, are balanced by them, so that their effect is, in the great average of human affairs, nowhere to be seen, and the total actions of mankind, considered as a whole, are left to be regulated by the total knowledge of which mankind is possessed;" 8. That individual efforts are insignificant in the great mass of human affairs, and that great men, although they *exist*, and must "at present" be looked upon as disturbing forces, are merely the creatures of the age to which they belong; 9. That religion, literature, and government are, at the best, the products and not the causes of civilization; 10. That the progress of civilization varies directly as "scepticism," the disposition to doubt and to investigate, and inversely "as credulity" or "the protective spirit," a disposition to maintain, without examination, established beliefs and practices.

These are all the general truths which are contained in Buckle's theory of history. And obviously, however ably advocated, however solidly established they might be, they must fall short of constituting a science of history, unless that science be one of unparalleled simplicity and vagueness. But probably none of them are completely made out; probably none of them are quite true; while several of them seem to be nearly altogether false. Buckle either could not define, or cared not to define, the general conceptions with which he worked, such as those denoted by the terms "civilization," "history," "science," "law," "scepticism," and "protective spirit;" the consequence is that his arguments are often fallacies. Whenever he treats of matters metaphysical, psychological, or theological, he shows plainly that his mind had been little exercised on such subjects. He assumes, without the slightest evidence, that law and free will, orderly historical development and providential government, the metaphysical method and the method of averages, obeying nature and ruling nature, are so many alternatives of which the terms contradict and exclude each other; it does not seem to have occurred to him that freedom and law, historical order and providential government, internal and external observation, might co-exist, or that Bacon might have had reason in writing—"*natura non nisi parendo vincitur*." The looseness of his statements and the rashness of his inferences regarding statistical averages make him, as a great authority has remarked, the *enfant terrible* of moral statisticians. He denies the influence of race without adequate consideration, and so exaggerates the power of climate, soil, food, and the aspects of nature, as at times to be fairly chargeable with physical fatalism. He neglects to raise the essential question, Must not certain moral conditions be realized before the accumulation and distribution of wealth are possible? In attempting to prove the unprogressiveness of moral knowledge he gives us such assertions as these:—"That the system of morals propounded in the New Testament contained no maxim which had not been previously enunciated, and that some of the most beautiful passages in the Apostolic writings are quotations from Pagan authors is well known to every scholar." "Systematic writers on morals reached their zenith in the 13th century, fell off rapidly after that period, were, as Coleridge well says, opposed by the 'genius of Protestantism,' and by the end of the 17th century became extinct in the most civilized countries,"—although the facts are, that the passages in the Apostolic writings known to be quotations from Pagan authors are just three in number, two of which have no claims to beauty, and that there have been more systematic writers on morals in the 19th century than there were writers of all kinds during the 13th. The reasoning employed to show that intellectual forces have been far more potent than moral forces in producing progress has many flaws, which have been often pointed out. What Buckle himself says of the achievements of Richelieu, Adam Smith, Voltaire, and others, and of the effects of the protective spirit in France and England, and of religious intolerance in Spain and Scotland, is irreconcilable with his doctrines that great men, government, and religion have had almost no influence on civilization. His paradox about scepticism and credulity is partly a truism inaccurately expressed and partly its exaggeration.

The larger part of Buckle's first volume, and the whole of the second, are composed of surveys of positive history, undertaken to prove the last of the general theses already mentioned. The rest of these theses are ignored, and some of them are even by implication contradicted, when he engages in actual historical work. Perhaps the historical work performed by him is none the worse on that account. The chief aim of the historical portion of the first volume is to trace the working of the protective spirit in its political form, and to show its civil tendencies. France, the most civilized country in which that spirit is very powerful, is chosen as the field of illustration, and the history of the intellect and policy of France is laid before us in outline, and compared and contrasted with that of England, the development of which is held to have been comparatively spontaneous and normal. The first chapter of the second volume gives a general view of the history of the Spanish mind from the 5th to the middle of the 19th century, designed to show why the protective spirit has prevailed in Spain in a religious form, and how it has isolated the Spanish nation from the rest of the world, weakened and degraded it, and hitherto frustrated all efforts at improvement. The other four chapters are designed to explain what Mr Buckle supposes to be the largest and most important fact in the history of Scotland, —the combination in its people of liberality in politics with illiberality in religion. In order to accomplish the explanation it is found necessary to argue that the Scottish Reformation was the work of the nobles, animated by hostility to the Roman Catholic priesthood; that the Protestant clergy, owing to being despised by the governing class, united themselves with the people, advocated democratic principles, and, favoured by the course of events, acquired an immense authority, the result of which was the general prevalence of extreme religious bigotry; that the Scotch philosophy of the 18th century, although a reaction against the theological spirit of the 17th, retained the theological method; and that, owing to its deductive character, that philosophy has been inaccessible to the average intellect of the nation, and powerless to free it

from the grasp of superstition. On the proof of these positions Buckle lavished labour, learning, and ingenuity, and, it will be generally admitted, attained some considerable results. But the results were by no means so great or certain as he himself imagined. Few competent judges will deny that, in regard alike to France and Scotland, he overlooked influences which had been as powerful in shaping the characters of these nations as those on which he laid exclusive stress. No explanation of French history can be satisfactory which does not attach due weight to the series of events by which the unity of France was built up, and which only begins after that unity was completed; no explanation of Scottish history can be satisfactory which slurs over the wars with England. The French Revolution was, as Buckle represents it, a reaction against the protective spirit,—but it was a great deal more, and that he did not see; the Scottish Reformation was due in some measure to the antagonism between the nobility and priesthood, as he has amply shown, but he might easily have still more amply shown that it was very far from wholly due to it. To some extent the Scotch philosophy of the 18th century was a reaction against the theological spirit of the 17th, as he saw; but to a much greater extent it was a natural development of British and even European thought, which he should not have overlooked. That either the Scottish philosophy or the Scottish intellect was essentially deductive he wholly failed to make out, and would never have tried to make out, had it not been that his views as to the difference between induction and deduction were strangely vague and confused. Hume was not as deductive as Hobbes. Adam Smith, at least as a political economist, was less deductive than Malthus and Ricardo. Black was less so than Dalton and Davy. To say that deduction is a prominent characteristic of Hutcheson, Reid, or Dugald Stewart, is glaringly contrary to fact. If their writings show any particularly Scottish trait, it is Scottish caution manifesting itself in suspicion of deduction.

Buckle had a high ideal of the historian's duties, and he laboriously endeavoured to realize it; but he fancied himself far more successful in the attempt than he really was, and greatly underrated what had been accomplished by others. He brought a vast amount of information from the most varied and distant sources to confirm his opinions, and the abundance of his materials never perplexed or burdened him in his argumentation, but examples of well-conducted historical inductions are rare in his pages. He sometimes altered and contorted the facts; he very often unduly simplified his problems; he was very apt when he had proved a favourite opinion true to infer it to be the whole truth. His intellect was comprehensive and vigorous, but neither classically cultured nor scientifically disciplined; it was amazingly stored with facts, but not rich in ideas; it was ambitious in aspiration, confident to excess in its own powers, and exceptionally unconscious of where its knowledge ceased and its ignorance began. It was deficient in imagination, poetical feeling, and sympathy. Hence Buckle was narrow and harsh in his judgments on certain great periods of time and large classes of men, on antiquity and the Middle Ages, on the clergy and statesmen, on heroes and martyrs. But he was fearlessly honest according to his lights, and gave expression to the most distasteful of his opinions with a manly openness. He paid great attention to his style, and it has been pronounced, by an eminently competent judge, "equal to the subject, precise enough for the demands of science, full, flowing, and flexible enough for every purpose of eloquence. Lucid when the business of the writer is to state, explain, or illustrate, it ascends, when anger at the oppressor or sympathy with the oppressed call upon it, to tones worthy of Edmund Burke himself denouncing the corruptions of England or the wrongs of India."

References.—Besides the works of Mr Buckle mentioned above, see *In the Morningland*, and especially *Pilgrim-Memories*, by J. S. Stuart-Glennie; A. von Oettingen's *Moralstatistik*, i. 155–172; J. G. Droysen's *Erhebung der Geschichte zum Rang einer Wissenschaft*, reprinted in his *Grundriss der Historik* from v. Sybel's *Zeitschrift*, ix. (1862); Laurent's *Philosophie de l'histoire*, 215–237; Bouillier's *Morale et Progrès*, 201–230; Etienne's *Positivisme en histoire* (*Rev. d. Deux Mondes*, Mars 15me 1868); *Edinburgh Review*, for April 1858, art. vii.; Prof. Masson in *Macmillan's Magazine* for July, August, and September 1861; J. H. Burton, *Phylax on Buckle*; J. Hutchison Stirling on "Buckle, his Problem and his Metaphysics" in the *North American Review*, July 1872, and on "Mr Buckle and the Aufklärung," in the *Journal of Speculative Philosophy*, October 1875, &c. (R. F.)

BUCKWHEAT, the seeds of various species of *Fagopyrum*, chiefly *F. esculentum*, a herbaceous plant, native of central Asia, but cultivated in Europe on account of its seeds. The seeds, as enclosed in their dark brown tough rind, are three-sided in form, with sharp angles, similar in shape to beech-mast, whence their name from the German *Buchweizen*, beechwheat. Buckwheat is grown in Great Britain only to supply food for pheasants and to feed poultry, which devour the seeds with avidity. In the northern countries of Europe, however, the seeds are employed as human food, chiefly in the form of cakes, which when baked thin have an agreeable taste, with a darkish somewhat violet colour. The meal of buckwheat is also baked into crumpets, as a favourite dainty among Dutch children, and in the Russian army buckwheat groats are served out as part of the soldiers' rations, which they cook with butter, tallow, or hemp-seed oil. Buckwheat is also used as food in the United States; and by the Hindus it is eaten on "bart" or fast days, being one of the phalahas or lawful foods for such occasions. When it is used as food for cattle the hard sharp angular rind must first be removed. As compared with the principal cereal grains, buckwheat is poor in nitrogenous substances and fat; but the rapidity and ease with which it can be grown render it a fit crop for very poor badly tilled land. According to Payen it contains—nitrogenous matter 13·10 per cent., starch 64·90, fat 3·00, water 13·00, cellulose and ash 6·00. An immense quantity of buckwheat honey is collected in Russia, bees showing a marked preference for the flowers of the plant. A dye-stuff is obtained from the leaves of a species of buckwheat, *Polygonum tinctorium*, which may be used for producing a yellow or olive colour on cotton, according to the mordant employed.

BUDA (German, OFEN), a royal free town of the kingdom of Hungary, is situated in 47° 29′ 10″ N. lat. and 19° 2′ 55″ E. long., on the right bank of the Danube, opposite the capital Pesth, with which it has been united since 1849 by a suspension bridge of much beauty, 1227 feet long and 39 feet wide. The nucleus of the town is the "fortress," which occupies an oblong elevation of porphyry rock, not unlike the Acropolis of Athens. It contains the royal palace, the mansions of Counts Sandor, Teleki, and Erdödy, the residence of the governor in command, the arsenal, and several buildings for official purposes. The palace includes the court church—where the regalia of Hungary are preserved, a picture gallery, and a library. Around this central portion there have grown up various suburbs, known respectively as the Wasserstadt, the Landstrasse, the Neustift, the Christinenstadt, and the Taban or Rascian town, the last of which derives its name from its Servian inhabitants, who are mainly vineyard owners. In the Wasserstadt are the church of St Anne and Elizabeth, and the military hospital; in Christinenstadt, the Horvath gardens, with the summer theatre, and the large country-house of Count Caraccioli; and in Old Buda are the royal barracks, part of which was once the monastery of

Mariazell. There are in the town upwards of fifteen churches, as well as several convents, and a Jewish synagogue. The educational establishments include a gymnasium of the highest class, an upper commercial school, five normal institutions, a school of design, a school of music, and about sixteen schools of lower grade. There is also an observatory in the town. Buda has long been celebrated for its mineral baths, which are five in number. The Bruckbad and the Kaiserbad were both founded by the Turks, and the buildings retain traces of Turkish occupation. The temperature of the water is about 118° Fahr. The town is commanded by the eminences known as the Spiessberg or Nap Hegy, and the Blocksberg or Gellert Hegy, the latter of which is crowned by a citadel. The industry of Buda comprises the making of cannon, type-founding, silk-weaving, coach-building, and the manufacture of majolica, copper wares, and gunpowder. A somewhat active trade is carried on in the red wine produced in the neighbouring vineyards, and Old Buda is the seat of a good deal of river traffic. The Danube Steam-Navigation Company have a considerable establishment there, in which a number of their vessels are built. In 1869 the population of the commune was 53,988. Old Buda was known to the Romans for its mineral springs; but the modern town dates only from the Middle Ages. In 1247 King Bela built a castle, which was originally regarded as belonging to Pesth; but the town which gradually gathered round it soon acquired an independent importance. In 1526 it was captured by the Turks, and in their hands became a place of pilgrimage, as well as an important military post. In 1686 it was wrested from them by Charles of Lorraine. During the Hungarian wars of the present century it played a distinguished part. In January 1849 the fortress was seized by the Austrian general Windischgrätz; but in May it was taken by storm by the Hungarians under Görgey. On their departure the Russians took possession, but shortly afterwards handed the place over to the Austrian forces.

BUDÆUS, or BUDÉ, GUILLAUME (1467–1540), descended of an ancient and illustrious family, was a native of Paris. At an early age he was sent to the schools of Paris, and afterwards to the university of Orleans to study law. He passed his time, however, in idleness, and being heir to a large fortune, was left, on his return to Paris, to follow his passion for gaming and pleasure. It was only when the fire of youth began to cool that he was seized with an irresistible passion for study; and having disposed of his hunting equipage, he abandoned business of every description, and applied himself wholly to literature. Without assistance, he made rapid progress, particularly in the Latin and Greek languages. The work which gained him greatest reputation was his treatise *De Asse*, the first edition of which was published at Paris in 1514. He was held in high esteem by Francis I., who was persuaded by him and by Du Bellay to found the Royal College of France, for teaching languages and sciences. He was sent by the king to Rome as ambassador to Leo X., and in 1522 was made master of requests. He died in Paris in 1540. Of his works, printed at Basel in 4 vols. folio in 1557, the most important is the *Commentarii Græcæ Linguæ*, which first appeared in 1529.

BUDAUN, a district of British India, in the Rohilkhand division, under the jurisdiction of the Lieutenant-Governor of the North-Western Provinces, lies between 27° 38′ and 28° 29′ N. lat., and 78° 21′ and 79° 35′ E. long., and is bounded on the N. by the British district of Moradabad, on the N.E. by the district of Bareilly, on the S.E. by that of Sháhjahánpur, on the S. by Farukhabad and Mainpuri, and on the west by Aligarh and Bulandshahr. The country is low, level, and is generally fertile, and watered by the Ganges, the Rámganga, the Sot or Yarwafádár, and the Maháwá. The area is 2004·84 square miles, of which 1376·94 square miles are under cultivation, 382·54 square miles cultivable but not actually under cultivation, and the rest uncultivable waste. The district population in 1872 amounted to 934,348 souls, residing in 193,589 houses, and inhabiting 2364 villages. Of the total population, 794,532 or 85·1 per cent. were Hindus, 139,687 or 14·9 per cent. Mahometans, 129 Christians and others of unspecified religion. Rice, wheat, sugar-cane, cotton, pulses, oil-seeds, and varieties of millet form the principal agricultural products of Budaun. The chief routes through the district are the roads from Farukhabad to Moradabad, from Agra to Bareilly, from Aligarh to Moradabad, and from Delhi to Bareilly. In 1870–71, the total revenue amounted to £130,424, of which £111,722 or 85 per cent. was derived from the land. In 1872–73 Budaun district contained 303 schools, attended by 4848 pupils. The following towns in the district have upwards of 5000 inhabitants:—Budaun, the administrative headquarters,—area, 335 acres, population 33,322; Islámnagar, population 5424; Ujháni, 7656; Sahaswán, 17,063; Bilsi, 5282; Alápur, 5347. Budaun district was ceded to the British Government in 1801 by the Nawab of Oudh. During the mutiny of 1857, the people of Budaun sided with the rebels, and the European officer in charge of the district only saved his life by flight.

BUDDÆUS, JOHN FRANCIS (1667–1729), a celebrated Lutheran divine, and one of the most learned men Germany has produced, was born at Anklam, a town of Pomerania, where his father was minister. He studied with great distinction at Greifswald and at Wittenberg, and having attained to eminence in languages, theology, and history, was appointed Greek and Latin professor at Coburg, afterwards professor of ethical science and politics in the university of Halle, and at length, in 1705, professor of divinity at Jena, where, after having acquired a very great reputation, he died in 1729.

His principal works are,—A large historical German Dictionary, Leipsic, 1709, folio; *Historia Ecclesiastica Veteris Testamenti*, Halle, 1709, 4 vols. 4to; *Elementa Philosophiæ Practicæ, Instrumentalis, et Theoreticæ*, 3 vols. 8vo, which has passed through a great number of editions; *Selecta Juris Naturæ et Gentium*, Halle, 1704, 8vo; *Miscellanea Sacra*, Jena, 1727, 3 vols. 4to; and *Isagoge Historico-Theologica ad Theologiam Universam, singulasque ejus partes*, 2 vols. 4to.

BUDDHISM

BUDDHISM is the name of a religion which formerly prevailed through a large part of India, and is now professed by the inhabitants of Ceylon, Siam, and Burma (the southern Buddhists), and of Nepāl, Tibet, China, and Japan (the northern Buddhists).[1] It arose out of the philosophical and ethical teachings of Siddhārtha Gautama, the eldest son of Suddhōdana, who was rāja in Kapilavastu, and chief of the tribe of the Sākyas, an Aryan clan seated during the 5th century B.C. on the banks of the Kohāna, about 100 miles N. of the city of Benāres, and about 50 miles S. of the foot of the Himālaya Mountains.

We are accustomed to find the legendary and the miraculous gathering, like a halo, around the early history of religious leaders, until the sober truth runs the risk of being altogether neglected for the glittering and edifying false-

[1] The number of Buddhists is now probably about 450,000,000. Professor Max Müller, *Chips from a German Workshop*, i. p. 214.

hood. Buddha has not escaped the fate which has befallen the founders of other religions; and as late as the year 1854 the late Professor Wilson of Oxford read a paper before the Royal Asiatic Society of London in which he maintained that the supposed life of Buddha was a myth, and "Buddha himself merely an imaginary being." No one, however, would now support this view; and it is admitted that, under the mass of miraculous tales which have been handed down regarding him, there is a basis of truth already sufficiently clear to render possible an intelligible history, which will become clearer and clearer as older and better authorities are made accessible.

The chief sources of our at present available information regarding the life of Buddha are—1, The *Manual of Buddhism*, published in 1860 by the Rev. R. Spence Hardy, compiled from various *Sinhalese* sources; 2, The translation into English (published by Bishop Bigandet in Rangoon in 1858 under the title *Legend of the Burmese Buddha*) of the translation into *Burmese* of a *Pāli* work called by Bigandet *Mallalingara-Wouttoo*, of unknown author and date; 3, The original *Pāli* text of the Jātaka commentary, written in Ceylon in the 5th century A.D., edited in 1875 by Mr Fausböll of Copenhagen (this is our best authority); 4, Mr Beal's recently published translation into English (under the title *The Romantic Legend of Sakya Buddha*) of a translation into *Chinese*, made in the 6th century A.D., of a *Sanskrit* work, called *Abhinishkramana Sūtra*; 5, A *Sanskrit* work called the *Lalita Vistara*, undoubtedly very old, but of unknown author or date, the text of which has appeared in the *Bibliotheca Indica* in Calcutta, and a translation through the Tibetan into French by M. Foucaux in Paris (1848). The first three books represent the views of the southern Buddhists, whose sacred books are in Pāli, and last the two those of the northern Buddhists, whose sacred books are in Sanskrit. The former are much the more reliable and complete, the latter being inflated to a great length by absurd and miraculous legends, the kernel of fact at the centre of which agrees in the main with the account found in the former. These have their miraculous incidents too, the relation of the Sanskrit sources to the Pāli resembling in many respects that of the apocryphal gospels to the New Testament.

As there has been little or no intercommunication between the two churches since the 3d century B.C., great reliance may reasonably be placed on those statements in which they agree; not indeed as a proof of the actual facts of the Buddha's biography, but as giving us the belief of the early Buddhists concerning it. It is to be regretted that the books we have to compare are, as yet, of so comparatively modern a date; but, after the respective canons had once been fixed, it is not likely that translators would deviate very materially from the text of the biographies, so sacred to them, with which they had to deal. The southern canon—usually called the Tripitaka or three collections—was finally determined about 250 B.C., at the Council of Pātaliputra on the Ganges, held under the auspices of the Emperor Asoka the Great; and the northern about the commencement of our era at the Council of Jālandhara, in Kashmir, held under Kanishka, a powerful Indo-Scythian monarch. To the former belongs the Buddhavansa, or History of the Buddhas, on which, together with its commentary, our three southern accounts are chiefly based; to the latter belongs the Lalita Vistara, the last of the authorities mentioned above.

At the end of this article will be found a description of those parts of the canon as yet published; for what is known of the contents of the unpublished parts the student is referred, for the northern, to B. H. Hodgson's *Essays*, pp. 17 *et seq.* and 36 *et seq.*; to Csoma Körösi in the *Asiatic Researches*, vol. xx.; Burnouf, *Intr.*, 34–68; and Köppen, ii. 279; for the southern to Hardy's *Eastern Monachism* (1850), p. 166 *et seq.*, and to M. Barthélemy St-Hilaire's papers in the *Journal des Savants* for Feb. and March 1866.

Part I.—The Life of Gautama Buddha.

At the end of the 6th century B.C. the Āryan tribes from the Panjāb had long been settled on the banks of the Ganges; the pride of race had put an impassable barrier between them and the conquered aborigines; the pride of birth had built up another between the chiefs or nobles and the mass of the Āryan people; and the superstitious fears of all yielded to the priesthood an unquestioned and profitable supremacy; while the exigencies of occupation and the ties of family had further separated each class into smaller communities, until the whole nation had became gradually bound by an iron system of caste. *The old child-like joy in life so manifest in the Vedas had* died away; the worship of nature had developed or degenerated into the worship of new and less pure divinities; and the Vedic songs themselves, whose freedom was little compatible with the spirit of the age, had faded into an obscurity which did not lessen their value to the priests. The country was politically split up into little principalities, each governed by some petty despot, whose interests were not often the same as those of the community. A convenient belief in the doctrine of the transmigration of souls satisfied the unfortunate that their woes were the natural result of their own deeds in a former birth, and though unavoidable now, might be escaped in a future state of existence by present liberality to the priests. While hoping for a better fate in their next birth, the oppressed people turned for succour and advice in this to the aid of astrology and witchcraft—a belief in which seems to underlie all religions, and is only just dying out among ourselves. The philosophy of the day no longer hoped for an immortality of the soul, but looked for a release from the misery which it found inseparable from life, in a complete extinction of individual existence. The inspiriting wars against the enemies of the Āryan people, the infidel deniers of the Āryan gods, had given place to a succession of internecine feuds between the chiefs of neighbouring clans; and in literature an age of poets had long since made way for an age of commentators and grammarians, who thought that the old poems must have been the work of gods. But the darkest period was succeeded by the dawn of a reformation; travelling logicians were willing to maintain theses against all the world; whilst here and there ascetics strove to raise themselves above the gods, and hermits earnestly sought for some satisfactory solution of the mysteries of life. These were the teachers whom the people chiefly delighted to honour; and though the ranks of the priesthood were for ever firmly closed against intruders, a man of lower caste, a Kshatriya or Vaisya, whose mind revolted against the orthodox creed, and whose heart was stirred by mingled zeal and ambition, might find through these irregular orders an entrance to the career of a religious teacher and reformer.

Sākyas, and who from their well-watered rice-fields could see the giant Himālayas looming up against the clear blue of the Indian sky. Their supplies of water were drawn from the River Rohini, the modern Kohāna; and though the use of the river was in times of drought the cause of disputes between the Sākyas and the neighbouring Koliyans, the two clans were then at peace; and two daughters of the rāja of Koli, which was only 11 miles east of Kapilavastu, were the principal wives of Suddhōdana. Both were childless, and great was the rejoicing when, in about the forty-fifth year of her age, the elder sister, Mahāmāyā, promised her husband a son. In due time she started with the intention of being confined at her parent's home, but the party halting on the way under the shade of some lofty satin trees, in a pleasant garden called Lumbini on the river side, her son, the future Buddha, was there unexpectedly born. The marvellous stories which gathered round the belief in his voluntary incarnation and immaculate conception, the miracles at his birth, the prophecies of the aged saint at his formal presentation to his father, and how nature altered her course to keep a shadow over his cradle, whilst the sages from afar came and worshipped him, will be referred to hereafter under the head of later Buddhism.

He was in after years more generally known by his family name of Gautama, but his individual name was Siddhārtha. When he was nineteen years old he was married to his cousin Yasodharā, daughter of the Koliyan rāja, and gave himself up to a life of Oriental luxury and delight. Soon after this, according to the southern account, his relations formally complained to the rajā that his son lived entirely for pleasure without learning anything, and asked what they should do under such a leader if war arose. Gautama, hearing of this, is said to have appointed a day for a trial of his prowess, and by defeating all his competitors in manly exercises, and surpassing even his teachers in knowledge, to have won back the good opinion of the disaffected Sākyas. This is the solitary record of his youth; we hear nothing more till, in his twenty-ninth year, it is related that, driving to his pleasure-grounds one day, he was struck by the sight of a man utterly broken down by age, on another occasion by the sight of a man suffering from a loathsome disease, and some months after by the horrible sight of a decomposing corpse. Each time his charioteer, whose name was Channa, told him that such was the fate of all living beings. Soon after he saw an ascetic walking in a calm and dignified manner, and asking who that was, was told by his charioteer the character and aims of the ascetics. The different accounts of this vary so much as to cast great doubts on their accuracy.[1] It is, however, clear from what follows, that about this time the mind of the young Rājput must, from some cause or other, have been deeply stirred. Many an earnest heart full of disappointment or enthusiasm has gone through a similar struggle, has learnt to look upon all earthly gains and hopes as worse than vanity, has envied the calm life of the cloister, troubled by none of these things, and has longed for an opportunity of entire self-surrender to abstinence and meditation.

Subjectively, though not objectively, these visions may be supposed to have appeared to Gautama. After seeing the last of them, he is said to have spent the afternoon in his pleasure-grounds by the river side; and having bathed, to have entered his chariot in order to return home. Just then a messenger arrived with the news that his wife Yasodharā had given birth to a son, his only child. "This," said Gautama quietly, "is a new and strong tie I shall have to break." But the people of Kapilavastu were greatly delighted at the birth of the young heir, the rāja's only grandson. Gautama's return became an ovation; musicians preceded and followed his chariot, while shouts of joy and triumph fell on his ear. Among these sounds one especially attracted his attention. It was the voice of a young girl, his cousin, who sang a stanza, saying, "Happy the father, happy the mother, happy the wife of such a son and husband." In the word "happy" lay a double meaning; it meant also freed from the chains of existence, delivered, *saved*.[2] Grateful to one who, at such a time, reminded him of his highest hopes, Gautama, to whom such things had no longer any value, took off his collar of pearls and sent it to her. She imagined this was the beginning of a courtship, and began to build day-dreams about becoming his principal wife, but he took no further notice of her and passed on. That evening the dancing-girls came to go through the Nātch dances, then as now so common on festive occasions in many parts of India; but he paid them no attention, and gradually fell into an uneasy slumber. At midnight he awoke; the dancing-girls were lying in the ante-room; an overpowering loathing filled his soul. He arose instantly with a mind fully made up,—"roused into activity," says the Sinhalese chronicle, "like a man who is told that his house is on fire."[3] He called out to know who was on guard; and finding it was his charioteer Channa, he told him to saddle his horse. While Channa was gone Siddhārtha gently opened the door of the room where Yasodharā was sleeping, surrounded by flowers, with one hand on the head of their child. He had hoped to take the babe in his arms for the last time before he went, but now he stood for a few moments irresolute on the threshold looking at them. At last the fear of awakening Yasodharā prevailed; he tore himself away, promising himself to return to them as soon as his mind had become clear, as soon as he had become a Buddha,—*i.e.* Enlightened,—and then he could return to them not only as husband and father, but as teacher and saviour. It is said to have been broad moonlight on the full moon of the month of July, when the young chief, with Channa as his sole companion, leaving his father's home, his wealth and power, his wife and child behind him—went out into the wilderness to become a penniless and despised student, and a homeless wanderer. This is the circumstance which has given its name to the Sanskrit work, the fourth of those mentioned above, of which Mr Beal has given us a version through the Chinese, the *Mahābhinishkramana Sūtra*, or *Sūtra of the Great Renunciation*.

Next is related an event in which we may again see a subjective experience given under the form of an objective reality. Māra, the great tempter, appears in the sky, and urges Gautama to stop, promising him, in seven days, a universal kingdom over the four great continents if he will but give up his enterprise. When his words fail to have any effect, the tempter consoles himself by the confident hope that he will still overcome his enemy, saying, "Sooner or later some lustful or malicious or angry thought must arise in his mind; in that moment I shall be his master;" and from that hour, adds the Burmese chronicle, "as a

[1] They all agree in making the four visions phantoms, saying that it was an angel who appeared under these forms, and was visible only to Buddha and his charioteer, who was specially inspired to say what he did. Some make all four visions appear on the same day, others on different days, and there are other discrepancies. Compare *Jātaka*, p. 59, with Bigandet, pp. 34, 35; Hardy, *M. B.*, pp. 153–155; Beal, pp. 107–111, and 115–123.

[2] The word used was *nibbuta*, the past participle passive of a verb, from the root of which is derived the word *nirvāna*; in Pāli, *nibbāna*. *Jātaka*, p. 60.

[3] Hardy, *M. B.*, p. 157; but compare Bigandet, p. 39, and *Jātaka*, p. 61, lines 28, 29. Beal, p. 131, gives a similar expression on a subsequent occasion, p. 165.

shadow always follows the body, so he too from that day always followed the Blessed One, striving to throw every obstacle in his way towards the Buddhahood."[1] Gautama rides a long distance that night, only stopping at the banks of the Anomā beyond the Koliyan territory. There, on the sandy bank of the river, at a spot where later piety erected a dāgaba (a solid dome-shaped relic shrine), he cuts off with his sword his long flowing locks, and taking off his ornaments, sends them and the horse back in charge of the unwilling Channa to Kapilavastu. The next seven days were spent alone in a grove of mango trees near by, whence the ascetic walks on to Rājagriha, the capital of Magadha, and residence of Bimbisāra, one of the then most powerful rulers in the valley of the Ganges. He was favourably received by the rāja, a friend of his father's; but though asked to do so, he would not as yet assume the responsibilities of a teacher. He attached himself first to a Brahman sophist named Alāra, and afterwards to another named Udraka, from whom he learnt all that Hindu philosophy had then to teach.[2] Still unsatisfied, he next retired to the jungle of Uruvela, on the most northerly spur of the Vindhya range of mountains, and there for six years, attended by five faithful disciples, he gave himself up to the severest penance and self-torture, till his fame as an ascetic spread in all the country round about "like the sound," says the Burmese chronicle "of a great bell hung in the canopy of the skies."[3] At last one day, when he was walking in a much enfeebled state, he felt on a sudden an extreme weakness, like that caused by dire starvation, and unable to stand any longer he fell to the ground. Some thought he was dead, but he recovered, and from that time took regular food and gave up his severe penance, so much so that his five disciples soon ceased to respect him, and leaving him went to Benares.

There now ensued a second struggle in Gautama's mind, described in both southern and northern accounts with all the wealth of poetry and imagination of which the Indian mind is master. The crisis culminated on a day, each event of which is surrounded in the Buddhist accounts with the wildest legends, on which the very thoughts passing through the mind of Buddha appear in gorgeous descriptions as angels of darkness or of light. To us, now taught by the experiences of centuries how weak such exaggerations are compared with the effect of a plain unvarnished tale, these legends may appear childish or absurd, but they have a depth of meaning to those who strive to read between the lines of such rude and inarticulate attempts to describe the indescribable. That which (the previous and subsequent career of the teacher being borne in mind) seems to be possible and even probable, appears to be somewhat as follows.

Disenchanted and dissatisfied, Gautama had given up all that most men value, to seek peace in secluded study and self-denial. Failing to attain his object by learning the wisdom of others, and living the simple life of a student, he had devoted himself to that intense meditation and penance which all philosophers then said would raise men above the gods. Still unsatisfied, longing always for a certainty that seemed ever just beyond his grasp, he had added vigil to vigil, and penance to penance, until at last, when to the wondering view of others he had become more than a saint, his bodily strength and his indomitable resolution and faith had together suddenly and completely broken down. Then, when the sympathy of others would have been most welcome, he found his friends falling away from him, and his disciples leaving him for other teachers. Soon after, if not on the very day when his followers had left him, he wandered out towards the banks of the Nairanjara, receiving his morning meal from the hands of Sujātā, the daughter of a neighbouring villager, and set himself down to eat it under the shade of a large tree (a *Ficus religiosa*), to be known from that time as the sacred Bo tree or tree of wisdom. There he remained through the long hours of that day debating with himself what next to do. All his old temptations came back upon him with renewed force. For years he had looked at all earthly good through the medium of a philosophy which taught him that it, without exception, contained within itself the seeds of bitterness, and was altogether worthless and impermanent; but now to his wavering faith the sweet delights of home and love, the charms of wealth and power, began to show themselves in a different light, and glow again with attractive colours. He doubted, and agonized in his doubt; but as the sun set, the religious side of his nature had won the victory, and seems to have come out even purified from the struggle. He had become clear in his mind, the Buddha, the Enlightened One, and had determined in the main to adhere to his belief; but from that night he not only did not claim any merit on account of his self-mortification, but took every opportunity of declaring that from such penances no advantage at all would be derived. All that night he is said to have remained in deep meditation under the Bo tree, and the orthodox Buddhists believe that for seven times seven nights and days he continued fasting near the spot, when the archangel Brahmā came and ministered to him. As for himself, his heart was now fixed,—his mind was made up,—but he realized more than he had ever done before the power of temptation, and the difficulty, the almost impossibility, of understanding and holding to the truth. For others subject to the same temptations, but without that earnestness and insight which he felt himself to possess, faith might be quite impossible, and it would only be waste of time and trouble to try to show to them "the only path of peace." To one in his position this thought would be so very natural, that we need not hesitate to accept the fact of its occurrence as related in the books. It is quite consistent with his whole career that it was love and pity for humanity—otherwise, as it seemed to him, helplessly doomed and lost—which at last overcame every other consideration, and made Gautama resolve to announce his doctrine to the world.

Gautama had intended to proclaim his new gospel first to his old teachers Alāra and Udraka, but finding that they were dead, he determined to address himself to his former five disciples, and accordingly went to the Deer-forest near Benares where they were then living. An old

[1] The word Buddha is always used in the Pāli texts as a title, not as a name. The historical Buddha, the Gautama of this article, taught that he was one of a long series of Buddhas, who appear at intervals in the world, and all teach the same doctrine. After the death of each Buddha his religion flourishes for a time and then decays, and is at last completely forgotten; until a new Buddha appears, who again preaches the lost truth (or Dharmma). The next Buddha will be Maitreya Buddha, the Buddha of kindness. A short account of each of the twenty-four legendary Buddhas who immediately preceded Gautama will be found in the *Jātaka*, pp. 2–44. See also Mahāvansa, p. 1; Hardy, *M. B.*, p. 49, *et seq.*

[2] The question of the relation between Buddhism and Hindu philosophy is one of extreme interest, but also of extreme difficulty. Except in its elementary principles Buddhist philosophy is at present very little understood; and our knowledge of the Hindu systems is derived from text books, all of which are probably post-Buddhistic, and are ascribed to authors of whom absolutely nothing is known. It seems clear that before the time of Buddha there was much philosophical activity in Northern India, and that his system and that of the six orthodox Hindu sects grew up side by side. Many of the technical terms are common to Buddhism and to one or more of the other systems, of which the Sānkhya and the Yoga, ascribed to Kapila and Patanjali respectively, come the nearest to Buddhism in their general views. A popular account of the six systems will be found in Professor Monier Williams's *Indian Wisdom*, pp. 48–154, and the student who wishes for further information is referred to the authorities there quoted. Beal has some interesting notices of Buddha's discussions with Hindu ascetics, pp. 152–161 and 169–177.

[3] Bigandet, p. 49; and compare *Jātaka*, p. 67, line 27.

gāthā or hymn of the northern Buddhists tells us how the Buddha meets, full of his newly-discovered mission, an acquaintance on the way, who, struck with his appearance, asks him what religion it is that makes him so glad and yet so calm. Gautama tells him that he has now become free from all desires, &c. But his acquaintance, apparently not caring much about these details, further asks him where he is going. The reply is striking. "I am now going," says Buddha, "to the city of Benares to establish the *kingdom of righteousness, to give light* to those enshrouded in darkness, and open the gate of immortality to men." His acquaintance only sneers at his high-flown pretensions, asking what he means by all this. The Buddha adds, "I have completely conquered all evil passions, and am no longer tied down to material existence; and I now only live to be the prophet of perfect truth." His acquaintance replies, "In that case, venerable Gautama, your way lies yonder," and turns away in the opposite direction.[1]

Nothing daunted, the new prophet walked on to Benares, and in the cool of the evening went on to the Deer-forest where the five ascetics were living. Seeing him coming, they resolved not to recognize as a superior one who had broken his vows; to address him by his name, and not as "master" or "teacher;" only, he being a Kshatriya, to offer him a seat. He understands their change of manner, calmly tells them not to mock him by calling him "the venerable Gautama;" that they are still in the way of death, where they must reap sorrow and disappointment, whereas he has found the way to salvation and can lead them to it. They object, naturally enough, from a Hindu point of view, that he had failed before while he was keeping his body under, and how can his mind have won the victory now, when he serves and yields to his body. Buddha replies by explaining to them the principles of his new gospel; and it will be necessary here to anticipate somewhat, and explain very briefly what this was, as the narrative will otherwise be difficult to follow.

The Buddhist Way of Salvation.—Everything corporeal is material, and therefore impermanent, for it contains within itself the germs of dissolution. So long as man is bound up by bodily existence with the material world he is liable to sorrow, decay, and death. So long as he allows unholy desires to reign within him, there will be unsatisfied longings, useless weariness, and care. To attempt to purify himself by oppressing his body would be only wasted effort; it is the moral evil of a man's heart which keeps him chained down in the degraded state of bodily life,—of union with the material world. It is of little avail to add virtue to his badness, for so long as there is evil, his goodness will only ensure him for a time, and in another birth, a higher form of material life; only the complete *eradication of all evil* will set him free from the chains of existence, and carry him to the "other side," where he will be no longer tossed about on the waves of the ocean of transmigration. But Christian ideas must not be put into these Buddhist expressions. Of any immaterial existence Buddhism knows nothing. The foundations of its creed have been summed up in the very ancient formula probably invented by its founder, which is called *the Four great Truths.* These are—1, That misery always accompanies existence; 2, That all modes of existence (of men or animals, in earth and heaven) result from passion or desire (tanhā); 3, That there is no escape from existence except by destruction of desire; 4, That this may be accomplished by following the fourfold way to Nirvāna. Of these four stages, called "*the Paths,*" the first is an awakening of the heart. There are few that do not acknowledge that no man can be really called happy, and that men are born to trouble as the sparks fly upwards, but the majority glide through life filling up their time with business or with pleasure, buoyed up with ever-changing hopes in their mad pursuit of some fancied good. When the scales fall from their eyes, when they begin to realize the great mystery of *Sorrow*, that pain is inseparable from existence, and that all earthly good leads to vexation of spirit, when they turn for comfort and for guidance to the Enlightened One, then they may be said to be awake, and to have entered the *first stage* of the Buddhist way of salvation. When the awakened believer has gone further, and got rid, firstly, of all *impure desires*, and then of all *revengeful feelings*, he has reached the second stage; in the third he successively becomes free (1) from *all evil desires*, (2) from *ignorance*, (3) from *doubt*, (4) from *heresy*, and (5) from *unkindliness and vexation.* "As even at the risk of her own life a mother watches over her child, her only child, so let him (the Buddhist saint) exert good-will without measure towards all beings."[2]

The order here observed is very remarkable. The way to be freed from doubt and heresy lies through freedom from impurity and revenge and evil longings of all kinds; or, in other words, if a man awakened to a deep sense of the mystery of sorrow wishes to understand the real facts of existence, wishes to believe not the false or the partly false, but the true altogether, Buddha tells him not to set to work and study, not to torture himself with asceticism or privation, but to purify his mind from all unholy desires and passions; right actions spring from a pure mind, and to the pure in heart all things are open. Again, the first enemy which the awakened believer has to fight against is sensuality, and the last is unkindliness; it is impossible to build anything on a foundation of mire; and the topstone of all that one can build, the highest point he can reach, the point above purity, above justice, above even faith is, according to Buddha, *Universal charity.* Till he has gained that the believer is still bound, he is not free, his mind is still dark; true enlightenment, true freedom are complete only in Love.

The believer who has gone thus far has reached the last stage; he has cut the meshes of ignorance, passion, and sin, and has thus escaped from the net of transmigration; Nirvāna is already within his grasp; he has risen above the laws of material existence; the secrets of the future and the past lie open before him; and when this one short life is over, he will be free for ever from birth with its inevitable consequences, decay, and death. No Buddhist now hopes to reach this stage on earth; but he who has once entered the "paths" cannot leave them; the final perseverance of the saints is sure; and sooner or later, under easier conditions in some less material world, he will win the great prize, and, entering Nirvāna, be at rest for ever.[3]

But to return to the narrative. For reasons too long to be specified here, it is nearly certain that Buddha had a commanding presence, and one of those deep, rich, thrilling

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[1] Beal, p. 245. Mr Beal translates the first clause, "to turn the wheel of the excellent law;" but the chakra is no ordinary wheel, it is the royal chariot wheel, and the expression rendered "turn," from the root *vrit*, is more exactly "to set rolling onward." A chakravarti is a universal monarch, the wheels of whose chariot roll on unresisted over the known world, and the figure employed in the gāthā undoubtedly means that Buddha was about to set rolling the royal chariot wheel of a universal kingdom of right, or, in other words, to start or found such a kingdom. Compare Beal, p. 244, note, and p. 142; and Childers's *Pāli Dictionary*, s.v., *Dhammacakkam.*

[2] *Metta Sutta*, as translated by Sir Coomāra Swāmy. *Sutta Nipāta*, p. 39, verse 7.

[3] For the four Truths and the four Paths see Hardy, *Manual of Buddhism*, p. 496; *Eastern Monachism*, p. 288; Csoma Körösi, *Asiatic Researches*, vol. xx. p. 294; Burnouf, *Introduction*, p. 629, and *Lotus de la Bonne Loi*, p. 517; Fausböll, *Dhammapada*, pp. 35, 195, 346; Childers, *Pāli Dictionary*, p. 269, s.v. *Nibbāna*; Gogerly in the *J.R.A.S.*, *Ceylon Br.*, 1845, pp. 24, 25.

voices which so many of the successful leaders of men have possessed. We know his deep earnestness, and his thorough conviction of the truth of his new gospel. When we further remember the relation which the five students mentioned above had long borne to him, and that they already believed those parts of his doctrine that are most repugnant to our modern feelings,—the pessimist view of life and the transmigration of souls,—it is not difficult to understand that his persuasions were successful, and that his old disciples were the first to acknowledge him in his new character. The later books say that they were all converted at once; but, according to the most ancient Pāli record,—though their old love and reverence had been so rekindled when Gautama came near that their cold resolutions quite broke down, and they vied with each other in such acts of personal attention as an Indian disciple loves to pay to his teacher,—yet it was only after the Buddha had for five days talked to them, sometimes separately, sometimes together, that they accepted in its entirety his plan of salvation.[1]

Gautama then remained at the Deer-forest near Benares until the number of his personal followers was about threescore, and that of the outside believers somewhat greater. The principal among the former was a rich young man named Yasa, who had first come to him at night out of fear of his relations, and afterwards shaved his head, put on the yellow robe,[2] and succeeded in bringing many of his former friends and companions to the teacher, his mother and his wife being the first female disciples, and his father the first lay devotee. It should be noticed in passing that the idea of a priesthood with mystical powers is altogether repugnant to Buddhism; every one's salvation is entirely dependent on the modification or growth of his own inner nature, resulting from his own exertions. The life of a recluse is held to be the most conducive to that state of sweet serenity at which the more ardent disciples aim; but that of a layman, of a believing householder, is held in high honour; and a believer who does not as yet feel himself able or willing to cast off the ties of home or of business, may yet "enter the paths," and by a life of rectitude and kindness ensure for himself a rebirth under more favourable conditions for his growth in holiness.

After the rainy season Gautama called together those of his disciples who had devoted themselves to the higher life, and whom, for want of a better name, we may call monks, and said to them, "Beloved Rahans, I am free from the five passions which, like an immense net, hold men and angels in their power; you too, owing to my teaching, enjoy the same glorious privilege. There is now laid on us a great duty, that of working effectually for men and angels, and gaining for them also the priceless blessing of salvation. Let us, therefore, separate, so that no two of us shall go the same way. Go ye now and preach the most excellent law, explaining every point thereof, unfolding it with diligence and care. . . . For my part I shall go to the village of Sena, near the deserts of Uruwela."[3] Throughout his career Gautama yearly adopted the same plan, collecting his disciples round him in the rainy season, and after it was over travelling about as an itinerant preacher; but in subsequent years he was always accompanied by some of his most attached disciples.

In the solitudes of Uruwela there were at this time three brothers, fire-worshippers and hermit philosophers, who had gathered round them a number of scholars, and enjoyed a considerable reputation as teachers. Gautama settled among them, and after a time they became believers in his system,—the elder brother, Kāsyapa, taking henceforth a principal place among his followers. His first set sermon to his new disciples is related by Bishop Bigandet under the name of the Sermon on the Mount, the subject of which was a jungle-fire which broke out on the opposite hillside. He warned his hearers against the fires of concupiscence, anger, ignorance, birth, death, decay, and anxiety; and taking each of the senses in order he compared all human sensations to a burning flame which seems to be something it is not, which produces pleasure and pain, but passes rapidly away, and ends only in destruction.[4]

Accompanied by his new disciples, Gautama walked on to Rājagriha, the capital of King Bimbisāra, who, not unmindful of their former interview, came out to welcome him. Seeing Kāsyapa, who as the chronicle puts it, was as well known to them as the banner of the city, the people at first doubted who was the teacher and who the disciple; but Kāsyapa put an end to their hesitation by stating that he had now given up his belief in the efficacy of sacrifices either great or small; that Nirvāna was a state of rest only to be attained by a change of heart; and that he had become a disciple of the Buddha. Gautama then spoke to the king on the miseries of the world which arise from passion, and on the possibility of release by following the way of salvation, which has been briefly sketched above. The rāja invited him and his disciples to eat their simple mid-day meal at his house on the following morning; and then presented Gautama with a garden called Veluvana or Bamboo-grove, afterwards celebrated as the place where the Buddha spent many rainy seasons, and preached many of his most complete discourses. There he taught for some time, attracting large numbers of hearers, among whom two, Sāriputra and Moggallāna, who afterwards became conspicuous leaders in the new crusade, then joined the Sangha, or Society, as Buddha's order of mendicants was called.

[1] *Jātaka*, p. 82, lines 11-19.
[2] See on this point below, p. 435.
[3] Compare Bigandet, pp. 53, 55, with Gogerly, *J.R.A.S.*, *Ceylon Br.*, 1852, pp. 14, 15.

world and the world that is to come. But, my father, when a man has found a treasure it is his duty to offer the most precious of the jewels to his father first. Do not delay; let me share with you the treasure I have found." Suddhōdana, abashed, took his son's bowl and led him to his house. There the women of the palace came to welcome him, but not Yasodharā, whom he had not seen since he had watched her sleeping in their chamber with their new-born babe by her side on that eventful night now seven long years ago. "I will wait and see," she had said; "perhaps I am still of some value in his eyes; he may ask, or come. I can welcome him better here." Gautama noticed her absence, and remembering, doubtless, that a recluse could not touch or be touched by a woman, he said, "The princess is not yet free from desire as I am; not having seen me so long she is exceeding sorrowful. Unless her sorrow be allowed to take its course, her heart will break. She may embrace me; do not stop her." He then went to her, and when she saw him enter,—not the husband she had mourned so long, but a recluse in yellow robes with shaven head and shaven face,—though she knew it would be so, she could not contain herself, and fell on the ground, and held him by the feet, and wept; then remembering the impassable gulf between them, she rose and stood on one side. The rāja thought it necessary to apologize for her, telling Gautama how entirely she had continued to love him, refusing to enjoy comforts which he denied himself, taking but one meal a day, and sleeping on a hard uncanopied bed. The different accounts often tell us the thoughts of the Buddha on any particular occasion; here they are silent, only adding that he then told a Jātaka story, showing how great had been her virtue in a former birth.[1] And then they parted: she became an earnest hearer of the new doctrines; and when long afterwards the Buddha was induced, much against his inclination, to established an order of female recluses, his widowed wife Yasodharā became one of the first of the Buddhist nuns.

The next day a great festival was to take place to celebrate the marriage of Gautama's half-brother, Nanda. Gautama went to the pavilion and said to Nanda, "the greatest festival after all is the destruction of all evil desires, the life of a recluse, the knowledge of truth, and the attainment of Nirvāna." He then gave him his alms-bowl, and Nanda followed him to the Nigrodha grove where he was staying. On their arrival there Gautama asked him if he would not enter the Society; but Nanda, though tenderly attached to his half-brother, with whom he had been brought up as a play-fellow (Gautama having no brothers of his own), did not yet desire to give up the world. After much persuasion, however, he consented, and became a disciple. A few days afterwards Yasodharā dressed Rāhula, her child and Gautama's, in his best, and told him to go and ask his father for his inheritance. "I know of no father," said the child, "but the rāja. Who is my father?' Yasodharā took him in her arms, and holding him up to the window pointed out to him the Buddha, who was then taking his mid-day meal at the palace. "That monk," she said, "whose appearance is so glorious, is your father; he has four mines of wealth; go to him, and entreat him to put you in possession of *your inheritance.*" Rāhula went up to Gautama and said to him, without fear and with much affection, "My father, how happy I am to be near you." Gautama silently gave him his blessing; but presently, when he rose to go, Rāhula followed him asking for his inheritance. None of the people stopped him, and Gautama still said nothing. When they reached the Nigrodha grove, he called Ṣāriputra, and said, "Beloved disciple, Rāhula is asking for a worldly inheritance which would avail him nothing; I will give him a spiritual inheritance which will not fade away; let him be admitted among us." When Suddhōdana heard this he was exceedingly grieved; he had lost his two sons as far as all worldly hopes were concerned, and now his grandson was taken from him. Full of sorrow he determined to save other parents a similar affliction, and going to Gautama asked him to establish a regulation that no one should in future be admitted to the Society unless he had the consent of his parents. Gautama granted this request, and after some more interviews with his father returned to the Bambu grove at Rājagriha.

Eighteen months had now elapsed since the turning-point *of Gautama's career—his great struggle under the Bo tree.* Thus far all the accounts agree, and follow chronological order. From this time they simply narrate disconnected stories about the Buddha, or the persons with whom he was brought into contact,—the same story being usually found in more than one account, but not often in the same order. It is not as yet possible, except very partially, to arrange chronologically the snatches of biography to be gleaned from these stories. They are mostly told to show the occasion on which some memorable act of Gautama's took place, or some memorable saying was uttered, and are as exact as to place as they are indistinct as to time. It would be impossible within the limits of this article to give any large number of them, but space may be found for one or two.

A merchant from Sūnaparanta having joined the Society was desirous of preaching to his relations, and is said to have asked Gautama's permission to do so. "The people of Sūnaparanta," said the teacher, "are exceedingly violent. If they revile you what will you do?" "I will make no reply," said the mendicant. "And if they strike you?" "I will not strike in return," was the reply. "And if they try to kill you?" "Death is no evil in itself; many even desire it, to escape from the vanities of life, but I shall take no steps either to hasten or to delay the time of my departure." These answers were held satisfactory, and the monk started on his mission.

At another time a rich farmer held a harvest home, and Gautama, wishing to preach to him, is said to have taken his alms-bowl and stood by the side of the field and begged. The farmer, a wealthy Brāhman, said to him, "Why do you come and beg? I plough and sow and earn my food; you should do the same." "I, too, O Brahman," said the beggar, "plough and sow; and having ploughed and sown I eat." "You profess only to be a farmer; no one sees your ploughing, what do you mean?" said the Brahman. "For my cultivation," said the beggar, "faith is the seed, self-combat is the fertilizing rain, the weeds I destroy are the cleaving to existence, wisdom is my plough, and its guiding-shaft is modesty; perseverance draws my plough, and I guide it with the rein of my mind; the field I work in is the law, and the harvest that I reap is the never-dying nectar of Nirvāna. Those who reap this harvest destroy *all the weeds of sorrow.*"

On another occasion he is said to have brought back to her right mind a young mother whom sorrow had for a time deprived of reason. Her name was Kisāgotamī. She had been married early, as is the custom in the East, and had a child when she was still a girl. When the beautiful boy could run alone he died. The young girl in her love for it carried the dead child clasped to her bosom, and went from house to house of her pitying friends asking them to give her medicine for it. But a Buddhist convert thinking

[1] *Jātaka*, 91, 2. These Jātaka stories are most interesting, containing as they do the oldest known versions of many of the nursery songs, and fairy tales, and comic stories, and fables, which are the common property of Europe in the present day. See Fausböll's papers enumerated in the report of the Philological Society for 1875, p. 64.

"she does not understand," said to her, "My good girl, I myself have no such medicine as you ask for, but I think I know of one who has." "Oh, tell me who that is?" said Kisāgotamī. "The Buddha can give you medicine; go to him," was the answer. She went to Gautama; and doing homage to him said, "Lord and master, do you know any medicine that will be good for my child?" "Yes, I know of some," said the teacher. Now it was the custom for patients or their friends to provide the herbs which the doctors required; so she asked what herbs he would want. "I want some mustard-seed," he said; and when the poor girl eagerly promised to bring some of so common a drug, he added, "you must get it from some house where no son, or husband, or parent, or slave has died." "Very good," she said; and went to ask for it, still carrying her dead child with her. The people said, "Here is mustard-seed, take it;" but when she asked, "In my friend's house has any son died, or a husband, or a parent, or slave?" They answered, "Lady! what is this that you say? the living are few, but the dead are many." Then she went to other houses, but one said "I have lost a son," another "We have lost our parents," another "I have lost my slave." At last, not being able to find a single house where no one had died, her mind began to clear, and summoning up resolution she left the dead body of her child in a forest, and returning to the Buddha paid him homage. He said to her, "Have you the mustard seed?" "My lord," she replied, "I have not; the people tell me that the living are few, but the dead are many." Then he talked to her on that essential part of his system, the impermanency of all things, till her doubts were cleared away, she accepted her lot, became a disciple, and entered the "first path."

For forty-five years after entering on his mission Gautama itinerated in the valley of the Ganges, not going further than about 150 miles from Benares, and always spending the rainy months at one spot—usually at one of the vihāras, or homes,[1] which had been given to the Society. In the twentieth year his cousin Ānanda became a mendicant, and from that time seems to have attended on Gautama, being constantly near him, and delighting to render him all the personal service which love and reverence could suggest. Another cousin, Dewadatta, the son of the rāja of Koli, also joined the society, but became envious of the teacher, and stirred up Ajātasatru (who having killed his father, Bimbisāra, had become king of Rājagriha) to persecute Gautama. The account of the manner in which the Buddha is said to have overcome the wicked devices of this apostate cousin and his parricide protector is quite legendary; but the general fact of Ajātasatru's opposition to the new sect and of his subsequent conversion may be accepted. The rival teachers, or sophists, as might be expected, were bitter enemies of the new philosophy, and the Brahmins did all they could to put down a faith which inculcated such dangerous doctrines as the equality within the Society of all ranks and castes, and the possibility of salvation without sacrifices or the assistance of the priests. They instigated certain men to murder Moggallāna, one of the two chief disciples, and made several attempts on the life of the teacher himself; but many of the chiefs, and the great bulk of the common people, are represented, with probable truth, as being uniformly in favour of his doctrine, though the number of those who actually joined the Society was comparatively small.

The confused and legendary notices of the journeyings of Gautama are succeeded by tolerably clear accounts of the last few days of his life. On a journey towards Kusinagara, a town about 120 miles N.N.E of Benāres, and about 80 miles due E. of Kapilavastu, the teacher, being then eighty years of age, had rested for a short time in a grove at Pāwā, presented to the Society by a goldsmith of that place named Chunda. Chunda prepared for the mendicants a mid-day meal, consisting of rice and pork; and it may be noticed in passing how highly improbable it is that any Buddhist would have invented the story of the Buddha's last illness having been brought on by such a cause. He started for Kusi-nagara in the afternoon, but had not gone far when he was obliged to rest, and soon afterwards he said, "Ānanda, I am thirsty;" and they gave him water to drink. Half-way between the two towns flows the River Kukushtā. There Gautama rested again, and bathed for the last time. Feeling that he was dying, and careful lest Chunda should be reproached by himself or others, he said to Ānanda, "After I am gone tell Chunda that he will receive in a future birth very great reward; for, having eaten of the food he gave me, I am about to pass into Nirvāna; and if he should still doubt, say that it was from my own mouth that you heard this. There are two gifts which will be blest above all others, namely, Sujātā's gift before I attained wisdom under the Bo tree, and this gift of Chunda's before I enter the final rest of Nirvāna." After halting again and again the party at length reached the River Hiranyavatī, close by Kusi-nagara, and there for the last time Gautama rested; and lying down under some Sal trees, with his face towards the south, he talked long and earnestly with Ānanda about his burial, and about certain rules which were to be observed by the Society after his death. Towards the end of this conversation, when it was evening, Ānanda broke down and went aside to weep, but Gautama missed him, and sending for him comforted him with the promise of Nirvāna, and repeated what he had so often said before about the impermanence of all things,—"O Ānanda! do not weep; do not let yourself be troubled. You know what I have said; sooner or later we must part from all we hold most dear. This body of ours contains within itself the power which renews its strength for a time, but also the causes which lead to its destruction. Is there anything put together which shall not dissolve? But you, too, shall be free from this delusion, this world of sense, this law of change. Beloved," added he, speaking to the rest of the disciples, "Ānanda for long years has served me with devoted affection. He knows all that should be done; after I am gone listen to his word." And he spoke to them

[1] These houses were at first simple huts, built for the mendicants in some grove of palm trees as a retreat during the rainy season; but they gradually increased in splendour and magnificence till the decay of Buddhism set in. See the authorities quoted in the *Journal of the Royal Asiatic Society* for 1875, p. 22 of the article on "Two Sinhalese Inscriptions."

indifference, are not to be found. O Subhadra! I do not speak to you of things I have not experienced. Since I was twenty-nine years old till now I have striven after pure and perfect wisdom, and following the good path, have found Nirvāna." A rule had been made that no follower of a rival system should be admitted to the Society without four months' probation. So deeply did the words or the impressive manner of the dying teacher work upon Subhadra that he asked to be admitted at once, and Gautama granted his request. Then turning to his disciples he said, "When I have passed away and am no longer with you, do not think that the Buddha has left you, and is not still in your midst. You have my words, my explanations of the deep things of truth, the laws I have laid down for the Society; let them be your guide; the Buddha has not left you." Soon afterwards he again spoke to them, urging them to reverence one another, and rebuked one of the disciples who spoke indiscriminately all that occurred to him. Towards the morning he asked whether any one had any doubt about the Buddha, the law, or the Society; if so, he would clear them up. No one answering, he said, "Beloved mendicants, if you revere my memory, love all the disciples as you love me and my doctrines." Ānanda expressed his surprise that amongst so many none should doubt, and all be firmly attached to the law. But Buddha laid stress on the final perseverance of the saints, saying that even the least among the disciples who had entered the first path only, still had his heart fixed on the way to perfection, and constantly strove after the three higher paths. "No doubt," he said, "can be found in the mind of a true disciple." After another pause he said, "Beloved, that which causes life, causes also decay and death. Never forget this; let your minds be filled with this truth. I called you to make it known to you." These were the last words Gautama spoke; shortly afterwards he became unconscious, and in that state passed away.

Part II.—Early Buddhism.

The accounts of Gautama's cremation and of the distribution of his relics are full of the miraculous, but it seems that the body was burnt with great reverence by the local rājas of Malva. Even before this ceremony had taken place dissensions began to break out in the Society,—one member of the order, Subhadra (not the Brahman mentioned above), having even gone so far as to rejoice that now at last they were free from control, and could not always be told to do this, or not to do that. Struck by this language, the chief disciples began at once to consider the expediency of holding a council, where all points of difference should be definitively set at rest. Chief among the leaders was the aged Kāṣyapa of Uruvela, whose distinguished position before his conversion, and his great learning, were not the only grounds of the respect in which he was held by the infant Society. He had been one of those most intimate with Gautama; so much so, that on one occasion, when walking together and talking of the deepest truths of their belief, the two friends had entered into a more than usual confidence and intercommunion of thought and feeling, and had then changed robes with one another in token of their sympathy and love. Sāriputra and Moggallāna were dead; but Ānanda, the beloved disciple, and Upāli, who though of low caste origin was looked up to in the Society as the greatest authority on points of conduct and discipline, were of one opinion with Kāṣyapa as to the advisability of a council. This was agreed upon; the disciples first separated and went to their homes, and when they met again for the rainy season in that vihāra at Rājagriha, which had been the first gift to the Society, the council was held under the presidency of Kāṣyapa, and with the patronage and assistance of Ajātaṣatru, the powerful rāja of Magadha. The number of believers present was five hundred, but if any discussion took place no tradition of it has survived. We are only told that at each daily sitting of the council which lasted seven months, Ānanda or Upāli repeated some portion of the law, and the whole assembly chanted it after them. A second council is said to have been held one hundred years later in Vaiṣāli, about 70 miles N. of Rājagriha, and another was certainly held about 250 B.C. under the Buddhist emperor Aṣoka, in his capital Pātaliputra, the Palibothra of the Greeks and the modern Patna. There is reasonable ground for belief that the sacred books of the Buddhists at present existing in Ceylon are substantially the same as the canon settled at this last council of Pātaliputra, and it is from these books that the modern accounts on which we are as yet obliged to depend purport to have been and, with some alterations and additions, undoubtedly have been derived. The orthodox Buddhists hold the present canon to be identically the same as that settled at the first council of Rājagriha; but the internal evidence of those parts of the canon which have as yet been published tends to show that they cannot possibly have been composed in their present state immediately after Buddha's death. The date, derived from Ceylon, which is usually assigned to that event is 543 B.C.; but those scholars who have devoted most attention to the point hold this calculation to contain a certain error of about 60 years, and a probable error of 80 to 100 more; so that the date for the death of Buddha would have to be brought forward to 400 B.C., or a few years later. As the date of Aṣoka's council has been determined with certainty to have been within a year or two of 250 B.C., there remains an interval of a century and a half between the first council and the earliest records now accessible to us, an interval amply sufficient for the growth of the supernatural element which they so largely contain. When these records have been published in the original Pāli, it may be possible to decide how far some portions are older than the rest, and how far it is possible to hold that they reproduce any earlier canon; at present we can only claim in the following brief outline to give an account of Buddhism as it existed 150 years after the decease of its founder. But when it is recollected that Gautama Buddha was himself learned in all the learning of his time; that he did not leave behind him a number of deeply simple sayings from which his followers subsequently built up a system, but had thoroughly elaborated a system of his own before his mission began; that during his long career as teacher he had ample time to repeat the principles and details of the system to his disciples over and over again, and to test their knowledge of it; and finally, that his principal disciples were, like himself, accustomed to the subtlest metaphysical distinctions, and trained to that wonderful command of memory which Indian ascetics then possessed,—when these facts are recalled to mind, it will be seen that much more reliance can be placed upon the doctrinal parts of the existing Buddhist canon than upon correspondingly late records of other religions, or on the biographical parts of the Buddhist canon itself.

The Abhidharma or *Philosophy*. Buddhism does not attempt to solve the problem of the ultimate origin of the kosmos.[1] It takes as its own ultimate fact the existence of the material world and of conscious beings living

[1] "When Mālunka asked Buddha whether the existence of the world is eternal or not eternal he made him no reply; but the reason of this was, that it was considered by Buddha as an inquiry that tended to no profit."—Hardy, *M.B.*, 375. Only a Buddha can comprehend how effects are produced by karma, or how the universe was brought into existence.—*Ibid.*, p. 8, note.

within it; and it holds that everything is subject to the law of cause and effect, and that everything is constantly, though perhaps imperceptibly, changing. Though in its principles it anticipates much that modern science has proved, in its details it does not, as might be expected, rise much above the beliefs most current at the time of its origin; but it has formulated them into a hypothetical system sufficiently consistent with itself to have satisfied Buddhists for more than 2000 years, however little consistent with actual truth. Scattered through space, it teaches, there are innumerable circular worlds in sets of three. All of these are exactly similar to our own, in the centre of which rises an enormous mountain, called Māha Meru, which is surrounded by seven concentric circles of rock of an enormous height, and the circle enclosed by the outermost is divided into four quarters, or great continents, part of one of which is Jambudvīpa, the earth in which we live. On the heights of Mahā Meru, and above it and the rock circles, rise the twenty-four heavens, and beneath it and the earth are the eight great hells. These heavens and hells are part of the material world, subject like the rest of it to the law of cause and effect, and the beings within them are still liable to rebirth, decay, and death. Between Mahā Meru and the outmost circle of rocks, the sun, moon, and stars revolve through space; and it is when they pass behind the first circle of rocks that they appear to the inhabitants of Jambudvīpa to set. This world, like each of the others scattered through space, is periodically destroyed by water, fire, or wind, but the sum of the demerits of the beings (men, animals, angels, &c.) who lived within it produces each time a new world, which in its turn is fated to be destroyed. The number of these beings never varies save on those few occasions when one of them either in earth or heaven attains Nirvāna; in every other case, as soon as an individual dies, another is produced under more or less material conditions, according as the sum of the former individual's demerits, minus the sum of its merits, was, at the time of its death, large or small. A belief in such hypotheses seems inconsistent with a fundamental tenet of Buddhist philosophy, that there are only two sources of knowledge, experience, and inference; but the hypotheses themselves are too intimately involved in the whole scheme of Buddhism to leave much doubt as to their having formed part of the original doctrine of its founder. They are, however, scarcely distinctive of Buddhism, but, like the pessimist view of life, are rather modifications of previous beliefs which Buddhism adopted into its system, and from the consequences of which it promised to relieve those who followed out its teachings.[1]

The two ideas of the utter vanity of all earthly good and the inevitable law of rebirth, decay, and death will be seen to lead naturally to the belief in Nirvāna. If life be an evil, and death itself be no delivery from life, it is necessary to go further back to discover the very origin, the seed, so to speak, of existence; and by destroying that to put an end at last to the long train of misery in which we are compelled to go again and again through the same weary round of experiences, always ending in disappointment. This seed of existence Buddhism finds in "Karma," the sum of merit and demerit, which, as each one's demerit is the greater of the two, often comes practically to much the same thing as *sin* or error. It forms the second link in the Buddhist chain of causation,[2] and arises itself from ignorance. Destroy that ignorance which brings with it such a progeny, cut the links of this chain of existence, root out karma with the mistaken cleaving to life, and there will be deliverance at last—deliverance from all sorrow and all trouble in the eternal rest of Nirvāna. Anything less than this would be a mockery of hope; for there is no life outside the domain of transmigration, and by the inevitable law of change that which causes existence of any kind would itself be the cause also of decay, and bring with it after a time the whole chain of evils from which the tired heart of man seeks relief.

To reach this end, to destroy karma, and thus to attain Nirvāna, there is only one way—the fourfold path already explained above, which is also summed up in the Buddhist books in the eight divisions, "right views, right thoughts, right speech, right actions, right living, right exertion, right recollection, and right meditation."[3] By these means ignorance will be overcome and karma destroyed, and after the organized being has been dissolved in death, there will be nothing left to bring about the production of another life. For it must be understood that while Buddhism occasionally yielded so far to popular phraseology as to make use of the word soul, it denies altogether that the word is anything more than a convenient expression, or that it has any counterpart in fact. Birth is not rebirth, but new birth; transmigration of soul becomes a transfer of karma; metempsychosis gives way to metamorphosis. As one generation dies and gives way to another—the heir of the consequences of all its vices and all its virtues, the exact result of pre-existing causes—so each individual in the long chain of life inherits all of good or evil that all its predecessors have done or been, and takes up the struggle towards enlightenment precisely there where they have left it. There is nothing eternal, but the law of cause and effect, and change; the kosmos itself is passing away; even karma can be destroyed; nothing is, everything becomes. And so with this organized life of ours, it contains within itself no eternal germ; it passes away like everything else, there only remains the accumulated result of all its actions. One lamp is lighted at another; the second flame differs from the first, to which it owes its existence. A seed grows into a tree and produces a seed from which arises another tree different from the first, though resulting from it. And so the true Buddhist saint does not mar the purity of his self-denial by lusting after a positive happiness which he himself is to enjoy hereafter. He himself will cease to be, but his virtue will live and work out its full effect in the decrease of the sum of the misery of sentient beings.

A not unnatural confusion has arisen from the fact that the result of each man's actions is held not to be dissipated as it were into many streams, but concentrated together in the formation of one new sentient being. This link of connection between the two otherwise distinct individuals has led to expressions in Buddhist writings which when read by Christians seemed to infer the existence of a soul. Phrases used of those living saints who have entered the fourth path, and have practically attained Nirvāna, have also been supposed by mistake to apply to Nirvāna itself. And when further Nirvāna has been described in glowing terms as the happy seat; the excellent eternal place of bliss, where there is no more death, neither decay; the end of suffering; the home of peace; the other side of the ocean of existence; the shore of salvation; the harbour of refuge; the medicine for all evil; the transcendent, formless, tranquil state, the Truth, the Infinite, the Unspeakable, the Everlasting,—it has been supposed by some European scholars to mean a blissful state in which the soul (?) still exists in an everlasting trance. Th[illegible]

[1] On the Buddhist cosmogony, see Hardy, *Manual of Buddhism*, chap. 1; Burnouf, *Lotus*, &c., pp. 842, *et seq.*; Beal, *Catena of Buddhist Scriptures from the Chinese*, Part I.; and Childers's *Pali Dict.*, under the names given by Hardy.

[2] *Paticca-samuppāda*, the twelve nidānas. See Childers in Colebrooke's *Essays* (1873), vol. ii. p. 453; Gogerly in the *Journal of the R.A.S., Ceylon Br.* 1845, p. 18, 1867, p. 127.

[3] From the third book of the Mahā Vagga, which is the first part of the first Piṭaka. Gogerly, in the *Journal of the Royal Asiatic Society, Ceylon Branch*, 1845, p. 24; this summary is constantly quoted.

however, now be no longer any doubt on the point. Spence Hardy and Bigandet find in the modern Sinhalese and Burmese books the same opinion as Alvis and Gogerly and especially Childers have found in the more ancient authorities; and though the modern books of the Northern Buddhists are doubtful, Eugène Burnouf has clearly proved that their older texts contain only the same doctrine as that held in the South. Buddhism does not acknowledge the existence of a soul as a thing distinct from the parts and powers of man which are dissolved at death, and the Nirvāna of Buddhism is simply Extinction.[1]

It will seem strange to many that a religion which ignores the existence of God, and denies the existence of the soul, should be the very religion which has found most acceptance among men, and it is easy to maintain that had Buddha merely taught philosophy, or had he lived in later ages, he might have had as small a following as Comte. Gautama's power over the people arose in a great degree from the glow of his practical philanthropy, which did not shrink in the struggle against the abuses most peculiar to his time; his philosophy and his ethics attracted the masses, from whose chained hands they struck off the manacles of caste, and in leaving the school for the world they insensibly became a religion. But there is no reason to believe that Gautama intended either at the beginning or the end of his career to be the founder of a new religion. He seems to have hoped that the new wine would go into the old bottles, and that all men, not excepting even the Brahmins, would gradually adopt his, the only orthodox, form of the ancient creed. However the question of the historical succession or connection between the different systems of Hindu philosophy be ultimately settled, whether any of them were post-Buddhistic or not, they afford at least sufficient evidence that beliefs very inconsistent with the practical creed of the masses met with little opposition from the priests so long as they were taught only in schools of philosophy; and Buddhist morality was not calculated to excite anger or hatred. But the very means which Gautama adopted to extend and give practical effect to his teaching, while giving it temporary success, led to its ultimate expulsion from India. It was his Society rather than his doctrine, the Sangha rather than the Dharma, which both gave to his religion its practical vitality and excited the active hostility of the Brahmins.

The SANGHA *or Society, the Buddhist Order of Mendicants.*—It was a logical conclusion from the views of life held by Gautama that any rapid progress in spiritual life was only compatible with an ascetic life, in which all such contact with the world as would tend to create earthly desires could be reduced as much as possible; and accordingly from the first he not only adopted such a mode of life for himself but urged it on his more earnest disciples. He contemplated no such division between clergy and laity as obtains in Christian countries, and constantly maintained that there was no positive merit in outward acts of self-denial or penance; but holding that family connections and the possession of wealth or power were likely to prolong that mistaken estimate of the value of things, that clinging to life which was the origin of evil, he taught that to forsake the world was a necessary step towards the attainment of spiritual freedom. Little by little, as occasion arose, he laid down rules for the guidance of those who thus devoted themselves to the higher life, and insensibly as he did so, the Society became more and more like one of the monkish orders which sprung up afterwards in the west. But not even now has the order become a priesthood. It possesses no mystic powers of regeneration or confirmation or absolution from sin; it works no miracles by consecration or by prayer, and its doors are always open alike to those who wish to enter and to those who wish to leave it. In a system which acknowledged no Creator and no God, the monks could never become the only efficient intercessors between man and his Maker; and since salvation was held to be and to depend upon a radical change in man's nature, brought about by his own self-denial and his own self-control, the monks could never obtain power over the keys of heaven and hell. When successive kings and chiefs were allowed to endow the society, not indeed with gold or silver, but with the few necessaries of the monkish life, including lands and houses, it gradually ceased in great measure to be the school of virtue or the most favourable sphere for intellectual progress, and became thronged with the worthless and the idle; but in the time of its founder it undoubtedly contained few besides those who longed under his guidance first to train themselves and then to preach to others the glad tidings of rest; that hope, to us so uninviting and so cold, to them—to whom life, under their glowing sky and under the oppressive weight of tyranny in church and state, was a burden too heavy to be borne—to them so welcome and so sweet, of utter rest in annihilation. For admittance to the Society no other credentials were at first required than the simple wish of the applicant; afterwards on different occasions a few necessary conditions were imposed, the applicant being obliged to state that he was free from contagious disease, consumption, and fits; that he was neither a slave nor a debtor nor a soldier, that is, that he was *sui juris;* and that he had obtained the consent of his parents. At first, also, the candidate was admitted without any ceremony by merely shaving his head, putting on the yellow robes, and leading an ascetic life; afterwards a simple ceremony was adopted, probably identical with that now in use in Ceylon, an excellent account of which has been given in the Journals of the Ceylon Asiatic Society for 1852 and of the Royal Asiatic Society for 1873. At first also there is no mention of any distinction within the ranks of the society; but the preparatory rank of novice was very early introduced, and later on, as the religion became more and more corrupted, the order became more and more subdivided, until in Tibet, in the 14th century, we find a complete episcopal hierarchy.

Rules of the Order.—The most usual names applied in the sacred books to the senior members of the order are Sramana and Bhikshu, and to the novices Sāmanera. The first, from which the third is derived, means one who exerts himself, controls himself; the second means simply a beggar. Self-conquest and poverty, then, were to be the distinguishing characteristics of the "sons of Sākya," but it was not left to them to decide for themselves how far this self-suppression and abstinence were to be carried. The teacher gave a number of rules and directions which have been handed down to us more or less correctly in the Vinaya, the first part of the Buddhist canon, and which are summed up in the "Pātimokkha," a book which, though not included in the canon, cannot be much later than the great council of Asoka, about 250, and is regarded with much reverence by the monks, from its having from time immemorial been ordered to be read twice monthly in every monastery. These rules may be roughly divided into two divisions, those which are obligatory, and those which, not being obligatory, are recommended to such as wish to work out their own salvation to a point further than that attainable by the ordinary rules. And first, as to *food.* No monk can eat solid food except between sunrise and noon, and

[1] On Nirvāna, see Gogerly, *Journal of the R. A. S., Ceylon Branch*, 1867-1870, Part i. p. 130; Alvis, *Buddhist Nirvāna*, Colombo, 1871; Childers, *Pali Dict.*, sub. v., Nirvāna; Burnouf, *Intr.*, 18-20, 78, 83, 155, 516-522, and esp. 589 *et seq.*, and *Lotus*, 355; Hardy's *Eastern Monachism*, 290-309; Bigandet, p. 320-323; Wassilief, *Der Buddhismus*, p. 101. On the other side, Prof. Max Müller, *Buddhaghosha's Parables*, xxxix-xlv.; Mohl, *Journal Asiatique*, 1856, p. 94; and Obry, *Du Nirvâna Bouddhique*, Paris, 1863.

total abstinence from intoxicating drinks is obligatory. The usual mode of obtaining food is for the monk to take his begging-bowl, a brown earthenware vessel, in shape nearly like a soup tureen without its cover, and holding it in his hands, to beg straight from house to house. He is to say nothing, but simply stand outside the hut, the doors and windows of which in India are usually large and open. If anything is put into his bowl he utters a pious wish on behalf of the giver and passes on; if nothing is given he passes on in silence, and thus begs straight on without going to the houses of the rich or luxurious rather than to those of the poor and thrifty. As the food of all classes consisted almost exclusively of some form of curry, the mixture was not so very incongruous, and when enough had been given, the monk retired to his home to eat it, thinking the while of the impermanence and worthlessness of the body which was thus nourished, and of the processes through which the food would have to pass. To express a Buddhist idea in the quaint words of Herbert, "Look on meat, think it dirt, then eat a bit, and say withal, Earth to earth I commit." From the first it was permitted to wealthy or pious laymen to invite one or more monks to take their mid day meal at their houses, and this was frequently done, especially on full moon days; it was also allowed to the laity on special occasions to bring food to the monastery. For the stricter monks further vows are mentioned of abstinence from animal food, of eating the whole meal without rising, of refusing all invitations and all food brought to them, of eating everything in the bowl without leaving or rejecting anything, and so on; but it is doubtful whether they are ever observed now, and they were formerly taken only for a time. Much later a practice sprung up of the order possessing rice fields, letting them out to be cultivated on condition of receiving a share of the produce, and then having their meals cooked at home by some lay follower or even slave.

As regards *residence*, Gautama considered a lonely life in the forest to be the most conducive to self-conquest; but as he himself, after having lived apart from the world, spent his life from the commencement of his prophetic career among men, so from the first the lonely life was adopted only by the most earnest, and that only for a time. The majority of the monks lived in companies in groves or gardens, and very soon the piety of laymen provided for them suitable monasteries, several of which were built even in the lifetime of Buddha. During the fine weather the monks often travelled from place to place, as their teacher did, but during the rainy season they always settled in one spot in or near a town; and near the ancient cities of India have been lately discovered extensive ruins on the site of the monasteries mentioned in the Pāli books. On the other hand, there have been found numerous rock caves, many of which, especially in Ceylon, were evidently meant for solitary hermits, and they often bear inscriptions in the old Pāli character, brought by Aṣoka's son Mahendra to Ceylon in the 3d century B.C.

As regards *clothing*, the monks were to be habited in clothes of no value, put together from cast-off rags; but here again the practice of Buddha himself, and that followed by the large majority of the brethren, was to dress in simple robes of dull orange colour, first torn to pieces and then sewed together again, so as to form two under garments, and one upper garment to cover the whole of the body except the right shoulder. All three are simply lengths of cotton cloth; the two under ones, the antara-vāsaka and the sanghāṭi, being wrapt round the middle of the body, and round the thighs and legs respectively; and the upper one, the uttarāsanga, being first wrapt round the legs and then drawn over the left shoulder. The colour was probably at first chosen as the one regarded with most contempt, because of its being nearly the same as that of very old rags of the common white cotton cloth, and because cloths of that colour were of no value at all for ordinary purposes; but the orange-coloured robes, from their very peculiarity as a sign of the members of the Sangha, soon came to be looked upon as an honour, and were sought after on that account alone; so that the Dhammapada, a collection of ethical verses, one of the books in the Buddhist canon, has to give a warning that those who are not free from sin (*kasāva*) are not worthy of the orange colour (*kāsāva*). In Buddhist countries men's ordinary dress is merely a cloth wrapt round the loins, whereas the monks are to cover the whole body, and are not permitted at any time to lay their robes aside. To do so would be to lay aside their membership of the order, to put on or to put off the robes being current expressions for joining or leaving the Society. Of course no ornaments are allowed, and even the natural ornament of hair is not permitted, complete tonsure being obligatory on all. No monk should possess more than one change of robes, and minute rules in detail are laid down to guard against any brother even by indirect methods taking any steps to procure himself new ones; to provide them spontaneously is the duty and privilege of the laity.

It is scarcely necessary to state that *sexual intercourse*, *theft*, and *murder* entail upon the culprit irrevocable expulsion from the order; while the ease with which the Society could be left provided an escape for those who found the vow of continence too hard to keep. On the vow of *poverty* a few words ought to be said. In his individual right no monk is to possess more than the following eight articles: 1, 2, 3, the three robes mentioned above; 4, a girdle for the loins; 5, an alms-bowl; 6, a razor; 7, a needle; 8, a water-strainer, through which he is to strain all he drinks—not only to remove impurities, but also and chiefly to prevent the accidental destruction of any living creatures. This individual vow of poverty has however been swallowed up by the permission given to the community to possess not only books and other personal property, but even lands and houses. Gautama himself is said to have received such gifts on behalf of the Sangha, which at the time of its expulsion from India must have rivalled in wealth the most powerful orders of the Middle Ages; and in some Buddhist countries at the present day the Society possesses enormous tracts of the most valuable land. But water-drinking celibates, who take only one meal a day, and dress in a simple uniform, could never indulge in unbounded personal luxury. Many members of the order enjoy the fascinating sense of wealth, so completely contrary to all the principles of their religion, and to the precepts laid down by their Teacher for the attainment of spiritual progress; they are often lazy and not seldom avaricious; but in the southern church at least they are not disgraced by gluttony or drunkenness, and have never given way to the weak vanity of dress, or of the pomp and pride of ritual.

which he has not sufficient self-control to reject. Twice a month, when the rules of the order are read, a monk who has broken them is to confess his crime. If it be slight some slight penance is laid upon him, to sweep the courtyard of the wihāra, or to sprinkle dust round the sacred Bo tree, but no inquisitorial questions are put to any one. Charges may be brought against a monk for breach of the ordinances laid down by Buddha, and must then be examined into by a chapter, but none can change or add to the existing law, or claim obedience from any other member of the order, however young.

The *daily life* of the novice should, according to a manual in Sinhalese called *Dina Chariyāwa*, be about as follows. He shall rise before daylight and wash, then sweep the wihāra and round the Bo tree, fetch the drinking water for the day, filter it, and place it ready for use. Returning to a solitary place he shall then meditate on the regulations. Then he shall offer flowers before the sacred dāgaba or Bo tree, thinking of the great virtues of the Teacher, and of his own faults. Soon after, taking the begging-bowl, he is to follow his superior in his daily round for food, and on their return is to bring water for his feet, and place the alms-bowl before him. After the meal is over, he is to wash the alms-bowl, then again retire, and meditate on kindness and love. About an hour afterwards he is to begin his studies from the books, or copy one of them, asking his superior about passages he does not understand. At sunset he is again to sweep the sacred places, and lighting a lamp, to listen to the teaching of his superior, and repeat such passages from the canon as he has learnt. If he finds he has committed any fault he is to tell his superior; he is to be content with such things as he has, and, keeping under his senses, to grow in wisdom without haughtiness of body, speech, or mind.[1] The superiors, relieved by the novices from any manual labour, were expected to devote themselves all the more earnestly to intellectual culture and meditation. There are five principal kinds of meditation, which in Buddhism takes the place of prayer. The first is called Maitrī-bhāvanā, or meditation on Love, in which the monk thinks of all beings, and longs for happiness for each. First, thinking how happy he himself would be if free from all sorrow, anger, and evil desire, he is then to wish for the same happiness for others; and lastly, to long for the welfare of his foes, remembering their good actions only, and that in some former birth his enemy may have been his father or his friend, he must endeavour in all earnestness and truth to desire for him all the good he would seek for himself. The second is Karunā-bhāvanā, or meditation on Pity, in which he thinks of all beings in distress, realizes as far as he can their unhappy state, and thus awakens the sentiment of pity. The third meditation is Muditā-bhāvanā, or meditation on Gladness, the converse of the last. The fourth is Asubha-bhāvanā, or Purity, in which the monk thinks of the vileness of the body, and of the horrors of disease and corruption, how everything corporeal passes away like the foam of the sea, and how by the continued repetition of birth and death mortals become subject to continual sorrow. We hear of the mirage in the desert cheating the unwary traveller's eyes with the promise of water to quench his burning thirst; but this mirage of human life, raising hopes of joy that turns bitter in the drinking, is a more real mockery. The fifth is Upekshā-bhāvanā, or the meditation on Serenity, wherein the monk thinks of all things that men hold good or bad,—power and oppression, love and hate, riches and want, fame and contempt, youth and beauty, decrepitude and disease,—and regards them all with fixed indifference, with utter calmness and serenity of mind.

[1] For Dina chariyāwa, see Hardy, *Eastern Monachism*, 24–28; for the five meditations, *ibid.* pp. 243, *et seq.*

The Duty of the Laity.—Gautama's ideal was that all men should sooner or later join the order, and thus that an end should be put at once to individual existence and to misery and sin; but even those who did not enrol themselves in the Sangha could obey many of the precepts, and by a virtuous life here raise themselves in their next birth to a higher and less material state of existence. Laymen could thus take the "three refuges," and keep five of the "ten precepts," viz., not to take life, to steal, to lie, to commit adultery or fornication, or to drink strong drink.[2] There are also ten commandments applicable to the laity, viz., to avoid taking life, theft, illicit intercourse, lying, slander, swearing, idle talk, covetousness, anger, and wrong belief, *i.e.*, either superstition, doubt, or heresy; the first three are sins of the body, the next four sins of the mouth, the last three sins of the mind. The following short extracts from the Buddhist Scriptures will perhaps give a better idea of the lay position in the Buddhist system than any longer description in modern terms. In answer to a question as to what he considered the *summum bonum*, Gautama is reported to have said—

"1. To serve wise men, and not to serve fools, to give honour to whom honour is due,—this is the greatest blessing. 2. To dwell in a pleasant land, to have done good deeds in a former birth, to have right desires for one's self,—this is the greatest blessing. 3. Much insight and much education, a complete training and pleasant speech, —this is the greatest blessing. 4. To succour father and mother, to cherish wife and child, to follow a peaceful calling,—this is the greatest blessing. 5. To give alms, and live righteously, to help one's relatives, and do blameless deeds,—this is the greatest blessing. 6. To cease and abstain from sin, to eschew strong drink, not to be weary in well doing,—this is the greatest blessing. 7. Reverence and lowliness, contentment and gratitude, the regular hearing of the law,—this is the greatest blessing. 8. To be long-suffering and meek, to associate with members of the Sangha, religious talk at due seasons,—this is the greatest blessing. 9. Temperance and chastity, a conviction of the four great truths, the hope of Nirvāna,—this is the greatest blessing. 10. A mind unshaken by the things of the world, without anguish or passion, and secure,—this is the greatest blessing. 11. They that act like this are invincible on every side, on every side they walk in safety, and theirs is the greatest blessing."[3]

Self-conquest and *universal charity*, these are the foundation thoughts, the web and the woof of Buddhism, the melodies on the variations of which its enticing harmony is built up. Such a religion could never remain buried in the cloister, or remain the privilege of the few. From the first it became an appeal to the many, and addressed itself not to the learned or the rich but to all mankind, to men and women, slaves and bondmen, Brahmins and Sūdras, nobles and peasants alike. The abuses of caste and priestcraft could no longer grow and thrive among men who looked at every question from a rationalistic standpoint, while their hearts were aglow with real and practical philanthropy. In Guatama's view men differed one from another not by the accident of birth, but by their own attainments and character; the same path to the same salvation lay equally open to all; and even in this life the poor and the despised were welcomed to the ranks of the order, where wealth was abandoned, and birth went for nothing in comparison with character or insight. It is true that, like Christianity, it did not in so many words condemn any of the political institutions amid which it arose; there is nothing said, at least in the older books, against slavery or despotism or wealth; and even as regards caste, Gautama did not directly interfere with it outside the limits of his Society. But the new wine soon burst the old bottles;

[2] Hardy, *Manual of Buddhism*, p. 460.

[3] The above is from the Pāli text of the Khuddaka Pāṭha, edited by Childers, in the *Journal of the Royal As. Soc.*, new series, vol. iv. part ii. Translations have been published by Prof. Childers, *loc. cit.*; by Sir Coomāra Swāmy in his *Sutta Nipāta*, p. 72; and by Gogerly, in the *Ceylon Friend* for June 1839.

the principles of the new creed were quite inconsistent with oppression and wrong of every kind; and the government of Asoka, as Buddhist emperor of India, was probably the most enlightened, and certainly the most philanthropic, which the natives of India have had.

Part III.—Later Buddhism.

It is not surprising that teaching so earnest and so high, so deep-reaching and so radical, should have met with eager acceptance among a people intensely religious, to whom the doctrines of the priests held out so little hope in exchange for the privileges it claimed from them on behalf of an oppressive caste. It is only to be regretted that the history of Buddhism in India lies under so thick a cloud that very little is known of it with certainty. Immediately after the death of Gautama the first council of 500 was held at Rājagriha, as related above, and the young church, in the vigour of its purity and fresh enthusiasm, spread very rapidly among the surrounding tribes. In less than 150 years after the death of its founder, the new religion had become the most powerful in Northern and Central India, and was the state religion of Magadha, whose kings claimed the superiority over the whole peninsula. It probably continued to gain in the number of its adherents till two or three centuries later, but soon after the commencement of our era it began to decay; though Fa Hian, a Chinese pilgrim, who visited India about 400 A.D., found it still flourishing over a large area, it was certainly not increasing, and scarcely maintaining its ground. Hiouen Thsang, another Chinese pilgrim, has left us an account of his journey made about two centuries later, and he found Buddhism in a much lower condition even than it had fallen to in the time of Fa Hian. In the 8th and 9th centuries a great persecution arose, and the Buddhists were so utterly exterminated that there is now not a Buddhist in all India; although of course the effects of so great a movement could not pass away, and it left its mark for ever on the Hinduism which supplanted it. The full reasons for this revolution are not known: but so much is clear, that long before its expulsion Buddhism had become very corrupt; the order had become wealthy and idle; and the laity, instead of following the precepts of the Teacher, had gone back to the old devil-worship, witchcraft, and astrology, which always underlay their nominal beliefs. From the great body of his followers the ethics and philosophy of Guatama were concealed by the mass of legends and superstitions which had grown up around the story of his life; and though the Buddhists no longer propitiated the favour of the gods by sacrifices of living beings, they rested their hopes more on their liberality to the monks than on the harder duties of self-control and charity,—the latter word having thus become even more limited in its meaning than it has among ourselves. Their worship of the relics of the Buddha came very near to rank idolatry; their reverence for their ancestors came very near to worship, and was a dangerous source of emolument to the monks; while the old Hindu gods were regarded much more highly than was at all consistent with the Buddhist Abhidharma

Buddhism had, however, been introduced into Ceylon, at a time when it was comparatively pure, by Mahendra and Sanghamitrā, the son and daughter of the emperor Asoka. It became at once the state religion, and the only religion of the island, on which Brahminism had never gained much hold. Protected there by its isolated position, and by the patriotic spirit which identified it with the Sinhalese nation, whose hereditary enemies, the Tamils, were first Jains and afterwards Hindus, it has retained almost its pristine purity to modern times. From Ceylon it was introduced into Burma in the 5th century A.D., whence it penetrated into Arakan, Kāmbaya, and Pegu, and finally into Siam in the 7th century of our era. As already mentioned, it became, in a less pure form, the state religion of Kashmir about the time of Christ, and was thence carried to Nepal and to Tibet and China. It would be impossible within the limits of this article to trace its various fortunes in these countries, but the following remarks may not be out of place.

It would be hazardous as yet to attempt to trace chronologically the growth of the Buddhist legends, but in one or other of the Buddhist books are found the following ideas, the growth of which was, under the circumstances, almost inevitable. Gautama himself became regarded as omniscient, and as absolutely sinless; he was supposed to have descended of his own accord from heaven into his mother's womb, and to have had no earthly father; angels were said to have assisted at his birth, immediately after which he walked three paces, and in a voice of thunder proclaimed his own greatness. On his formal presentation to his father, an aged saint is said to have worshipped him and prophesied that he would become a Buddha, who would show the people the way of salvation. When the babe was five months old, he was left under a tree, where he meditated so deeply that he worked himself into a trance; and five wise men who were journeying northwards through the air, being miraculously stopped over the place where he was, came down and worshipped him, the hymn put into their mouths surprising us in the midst of so absurd a legend by its beauty; in five stanzas they announce that the babe shall be the teacher of a law which shall be the water to extinguish all the fires of the sorrows of life, the light to enlighten the world, and the chariot to carry us through this wilderness to the promised land; that he shall deliver men from the bonds and shackles of the world, and be the great physician to heal all their diseases, and do away with the miseries of life and death. The only other legend we have of his youth is one in which he is said to have surpassed all his contemporaries in feats of bodily and mental skill, and even to have taught his teachers,—the later forms of this legend bearing a curious resemblance to some parts of the apocryphal "Gospel of the Infancy." In the accounts of his father's home and of his marriage he is surrounded with all the state and wealth of the eldest son and heir to a powerful monarch, whereas it is apparent from the geographical and other details that his father's power can only at most have extended a few miles from his home. It was a pious task to make his abnegation and condescension greater by the comparison between the splendour of the position he abandoned and the poverty in which he afterwards lived; and in countries distant from Kapilavastu the inconsistencies between these glowing accounts and the very names they contain would pass unnoticed by credulous hearers. With the same object of magnifying the person of Buddha, he is related in the legends to have performed at various times a very large number of miracles, mostly mere manifestations of power of no direct advantage to any one, and only designed to impress those who beheld or might hear of them with a belief in his great superiority over other teachers. Of

enough to notice here that it is called by them the Great Vehicle, in contradistinction to that of the southern church, which they call, not without some contempt, the Little Vehicle; and the Great Vehicle, while holding fast to the real foundation of Buddhism, its ethical views of self-conquest and charity, has in fact developed an entirely new religion. This is based on the worship of Maitreya, the Dhyāni-buddhas, Manjūṣri, and Avalōkitēswara, personifications respectively of charity, meditation, serenity, and wisdom. The first of these appears in ancient Buddhism as the name of the Buddha to come, and the last is the holy spirit of the northern Buddhist church. Among the Dhyāni-buddhas, who are philosophical abstractions corresponding to the earthly Buddhas, Amitābha, *i.e.*, Infinite Light, is the heavenly counterpart of Gautama, and soon took the most important place. Avalōkitēswara "proceeded" from him, and manifests him to the world since the death of Buddha; and his worship in the 10th century of our era bore its full fruit in the invention of a being, Ādibuddha, the origin of all things, who, using the wisdom within him, produced by meditation the five Dhyāni-buddhas, of whom Amitābha is the fourth,—a notion curiously similar to the theosophy of the Gnostics, and utterly opposed to the Agnostic materialism of Buddha.

In Tibet especially, the development in doctrine was followed by a development in ecclesiastical government, which runs so remarkably parallel with the development of the Romish hierarchy as to awaken an interest which could scarcely otherwise be found in the senseless and fatal corruptions which have overwhelmed the ancient Buddhist beliefs. The Buddhism introduced into that country in the 7th and 8th centuries of our era was a form of the Great Vehicle, already much corrupted by Siva-ism, a mixture of witchcraft and Hindu philosophy; but it worked a great change among the savage races who then inhabited those remote valleys. In the 13th century the country was possessed by independent chiefs, who struggled with the abbots of the great monasteries for power over the people; and the crozier proved itself in the long run more powerful than the sword. We then find the two leading priests or archbishops, the Pantshen Lāma and the Dalai Lāma, claiming to be official incarnations of Amitābha and Avalōkitēswara; and the latter as such succeeded in obtaining superior political and secular power, leaving to his brother pope his high ecclesiastical position and the aroma of holiness—a division of power which has again resulted in a Guelph and Ghibelin-like rivalry. Lāmaism, with its shaven priests, its bells and rosaries, its images and holy water, its popes and bishops, its abbots and monks of many grades, its processions and feast-days, its confessional and purgatory, and its worship of the double Virgin, so strongly resembles Romanism, that the first Catholic missionaries thought it must be an imitation by the devil of the religion of Christ; and that the resemblance is not in externals only is shown by the present state of Tibet—the oppression of all thought, the idleness and corruption of the monks, the despotism of the Government, and the poverty and beggary of the people.

Of the sacred books of the Northern Buddhists, we have in the original debased Sanskrit only the "Lalita Vistara" a legendary life of Buddha, published in the *Bibliotheca Indica* at Calcutta, the translations of which are mentioned in the beginning of this article. Of the canon of the Southern Buddhists, which is about twice the length of our Bible, we have in the original Pāli only—1. the Dhammapada, a collection of didactic poems edited by Mr Fausböll of Copenhagen, with a Latin translation in 1855; 2. The Khuddaka Pātha, a small collection of hymns published by Professor Childers, with English translation, *Journal of the Royal Asiatic Society* for 1869; and 3. The Upasampāda-kammavācā, the ritual by which laymen are admitted to the order, published by Mr Dickson in the *Journal of the Royal Asiatic Society* for 1873. The Pātimokkha, a manual of the rules of the order in Pāli, has been published by Mr Minayeff with a Russian translation, in 1867. A fuller account by the writer of this article of all the work already accomplished in the editing of Pāli texts, dictionaries, and grammars, will be found in the *Report of the Philological Society for* 1875. Of European works on Buddhism the following are the most important, and references will be found in them to the many smaller treatises on the subject:—Eugène Burnouf, *Introduction à l'histoire du Bouddhisme Indien*, 1844, and *Le Lotus de la Bonne Loi*, 1852; The Rev. Spence Hardy's *Eastern Monachism*, 1850, *Manual of Buddhism*, 1860, and *Legends and Theories of the Buddhists*, 1866, all compiled from Sinhalese sources; Bishop Bigandet's *Legend of the Burmese Buddha*, 1858, 2d edition 1866; St Julien's *Histoire de la vie de Hiouen Thsang*, 1853, and *Mémoires sur les contrées occidentales*, 1856; Professor Lassen's *Indische Alterthumskunde*, vol. ii. 1849, 2d edition 1875; Wassilief *Der Buddhismus, seine Dogmen und Literatur*, 1860, of which a French translation appeared in Paris in 1865; Köppen's *Religion des Buddha*, vol. i. on *Southern Buddhism*, 1857, vol. ii. on *Lāmaism*, 1859; The Rev. Samuel Beal's *Travels of Fa Hian and Sung Yun*, 1869, *Catena of Buddhist Scriptures from the Chinese*, 1871, and *Romantic History of Sākya Buddha from the Chinese-Sanskrit*, 1875; Captain Rogers's *Buddhaghosha's Parables* (from the Burmese), with introduction by Professor Max Müller, 1870; Schlagintweit's *Buddhism in Tibet*, 1863; A. Schiefner, *Eine Tibetische Lebensbeschreibung Schakjamunis*, 1849; Hodgson, *Essays*, 1874. A very large number of other writings on Buddhism have also been published either separately or in different learned journals in Europe and India. Those who wish to refer to those papers will find a list, very complete up to date, of all works, large or small, on the subject in Otto and Ristner's *Buddha and his Doctrines*, a bibliographical essay published in 1869 by Messrs Trübner and Co. of London (T. W. R. D.)

BUDGELL, Eustace (1685-1736), a literary man of some eminence in his time, the son of Dr Gilbert Budgell, was born at St Thomas, near Exeter. He was educated at Christ Church, Oxford, from which he removed to the Inner Temple, London; but instead of studying law, he devoted his whole attention to literature. He was befriended by Addison, who was first cousin to his mother, and who, on being appointed secretary to Lord Wharton, lord-lieutenant of Ireland in 1710, took Budgell with him as one of the clerks of his office. Budgell, who had read the classics and the best English, French, and Italian authors, took part with Steele and Addison in writing the *Tatler*. He was also a contributor to the *Spectator* and the *Guardian*,—his papers being marked with an X in the former, and with an asterisk in the latter. He was subsequently made under-secretary to Addison, chief secretary to the lords justices of Ireland, and deputy-clerk of the council, and was afterwards chosen a member of the Irish parliament. In 1717, when Addison became principal secretary of state in England, he procured for Budgell the place of accountant and comptroller-general of the revenue in Ireland. But the next year, the duke of Bolton being appointed lord-lieutenant, Budgell wrote a lampoon against Mr Webster, his secretary, in which the duke himself was not spared. This led to his removed from his post of accountant-general, upon which he returned to England, and, contrary to the advice of Addison, published his case in a pamphlet. In the year 1720 he lost £20,000 by the South Sea scheme, and afterwards spent £5000 more in unsuccessful attempts to get into parliament. This completed his ruin. He at length employed himself in writing pamphlets against the ministry, and published many papers in the *Craftsman*. In 1733 he began a weekly periodical called the *Bee*, which he continued for above a hundred numbers. By the will of Dr Matthew Tindal, who died in 1733, a legacy of 2000 guineas was left to Budgell; but the bequest (which had, it was alleged, been inserted in the will by Budgell himself) was successfully disputed by

Tindal's nephew and nearest heir, the continuator of Rapin's *History of England*. Hence the satirist—

> "Let Budgell charge low Grub Street on my quill,
> And write whate'er he please—except my will."

It was thought that he had some hand in publishing Dr Tindal's *Christianity as Old as the Creation;* for he often talked of an additional volume on the subject, but never published it. After the cessation of the *Bee*, he became so involved in lawsuits that he was reduced to very distressing straits. He then studied law, and was called to the bar, attending the courts for some time; but being unable to make any progress, and finding his prospects utterly ruined, he determined to put an end to his life. Accordingly, in 1736, he took a boat at Somerset-stairs, after filling his pockets with stones, ordered the waterman to shoot the bridge, and while the boat was passing under it threw himself into the river. On his desk was found a slip of paper with the words—"What Cato did, and Addison approved, cannot be wrong."

Besides the works mentioned above, he wrote a translation of the *Characters* of Theophrastus He never married, but left one natural daughter, who afterwards assumed his name, and became an actress at Drury Lane.

BUDGET (lit. a bag or small sack), the name applied to an account of the ways and means by which a minister of finance purposes to defray the expenditure of the state. In the United Kingdom the chancellor of the exchequer, usually in April, lays before the House of Commons a statement of the actual results of revenue and expenditure in the past finance year ending March 31, showing how far his estimates have been realized, and what surplus or deficit there has been in the income as compared with the expenditure. This is accompanied by another statement in which the chancellor gives an estimate of what the produce of the revenue may be in the year just entered upon, supposing the taxes and duties to remain as they were in the past year, and also an estimate of what the expenditure will be in the current year. If the estimated revenue, after allowing for normal increase of the principal sources of income, be less than the estimated expenditure, this is deemed a case for the imposition of some new, or the increase of some existing, tax or taxes. On the other hand, if the estimated revenue shows a large surplus over the estimated expenditure, there is room for remitting or reducing some tax or taxes, and the extent of this relief is generally limited to the amount of surplus realized in the previous year. The chancellor of the exchequer has to take parliament into confidence on his estimates, both as regards revenue and expenditure; and when the taxation and expenditure obtain the assent of parliament, the results as thus adjusted become the final budget estimate for the year. This system of annual review and adjustment of the public finances obtains not only in the British colonies, but is carried out, with remarkable despatch for so great an empire, in British India. The Indian budget, giving the results of income and expenditure in the year ending December 31, and the prospective estimates, is laid before the Imperial Parliament in the course of the ensuing session. The budget, though modified by different forms, has also long been practised in France, the United States, and other constitutional countries, and of late years has in some cases been adopted by arbitrary powers. Russia began the publication of annual budgets in 1866; Egypt has followed the example: and Turkey, if financially reinstated, will have to submit to a more strict account of her income and expenditure. Apart from national budgets, to be discriminated (1) as budgets passing under parliamentary scrutiny and debate from year to year, and (2) budgets emitted on executive authority, there are in all the greater countries local and municipal taxations and expenditures of only less account than the national. The ordinary budget of the city of Paris has increased from £1,600,000 in the reign of Louis Philippe to £8,000,000 at the present time; while the extraordinary budget, relating chiefly to public improvements and the city debt, is over £4,000,000 more. In federal governments, such as the United States, the German Empire, or the Argentine Republic, the budgets of the several states of the federation have to be consulted, as well as the federal budget, for a knowledge of the finances. The local taxation of the United Kingdom is equal to nearly one half the imperial revenue, and requires in its various provinces the same process of examination. The budget is an essential part of the machinery of representative Governments; and in the rapid progress of state loans, it has begun to be acknowledged by despotic Governments as a necessary basis of confidence between them and their creditors.

BUDWEIS (in Bohemian, *Ceske Budegorice*) the capital of a circle in the Austrian kingdom of Bohemia, is situated on the right bank of the Moldau, at its junction with the Maltsch, in 48° 59′ N. lat. and 14° 30′ E. long. It is well built and partially fortified. Chief among its public buildings are the council house—a handsome structure, and the cathedral, with a great detached tower, built in 1500; it has also an episcopal palace, two gymnasiums, a theological seminary, a training college, a deaf and dumb institution, a theatre, a hospital, and a poorhouse; and a short distance to the north stands the castle of Frauenburg, belonging to Prince Schwarzenberg. Its manufactures are very various, and comprise pottery, nails, wire, parquetry, musical instruments, black-lead pencils, sugar, beer, vinegar, and liqueurs. There are silver and gold mines in the mountains to the east of the town, which are still worked with considerable profit. The railway from Budweis to Linz, laid in 1827 for horse-cars, was the first line constructed in Germany. Budweis was founded by Ottocar II. in 1256, and was received into the number of privileged cities by Frederick II. In 1611 the town was captured by the people of Passau, but was retaken by the imperial general Bouquoi. In 1742, it was besieged by the Bavarians. Population in 1869, 17,413.

BUENOS AYRES, the largest and most important province of the Argentine Republic, is bounded on the N. by the Parana, which separates it from the province of Entre Rios, and by the provinces of Santa Fé, Cordova, and San Luis; on the E. by the Atlantic; on the S. by Patagonia; and on the S. and W. by the country of the Indians, which extends westwards to the Andes. The area of the province is estimated at about 440,000 square miles. Its seaboard along the Rio de la Plata and the ocean is upwards of 900 miles in length. According to the last census of 1869 the population was 488,706, of which 171,404 belong to the city of Buenos Ayres; in the present year (1876) it may be estimated at 600,000, of which 220,000 belong to the city, and 380,000 to the province. By the last returns the number of immigrants is from 60,000 to 90,000 per annum, the greater part of whom remain in the province of Buenos Ayres.

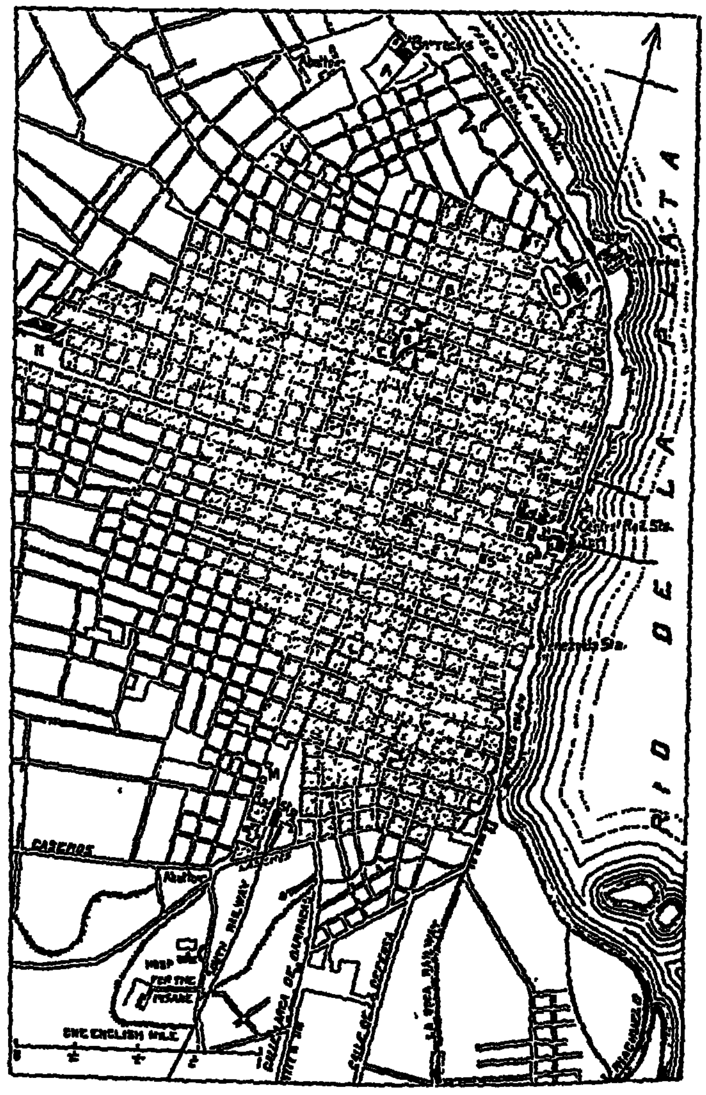
extremity of the province), possesses great natural advantages, which are by no means adequately appreciated. It might be turned to good account as a starting-point for vessels engaged in trade with the South American states that border upon the Pacific, but the difficult and sometimes dangerous navigation of the adjoining seas counterbalances in the meantime the other advantages which it offers. The interior of the country, except where it is intersected by the low mountain ranges of the Ventana and Vaulcan in its southern portions, and the spurs of the Andes in the west, is one vast plain, of which by far the larger part is laid out in *estancias*, or cattle farms, though the soil is in itself well adapted for producing all the European cerealia. Agricultural pursuits, however, are by no means in favour with the natives, who cannot bring themselves to engage in any pursuit that cannot be prosecuted on horseback. "Every man, woman, and child in the country rides," says Parish. "One might fancy one's self in the land of centaurs, amidst a population half-men, half-horses. Even beggars ride on horseback." Some of the cattle-farms are of immense extent; one in particular is mentioned by travellers as comprising more than 300 square miles of land, and yielding an enormous revenue to the proprietor. Some of the largest of them belong to British settlers, and are worked by British servants. The cattle were formerly hunted down and killed merely for the sake of their hides and tongues, while the carcases were abandoned to beasts and birds of prey. They are now slaughtered in abattoirs, where every part of the animal is made available. The beef is salted for exportation; the tallow is boiled down, and now forms an important item in the farmer's revenue; and the trade in hides is steadily increasing. Beef and an infusion of the native tea are the staple food of the natives. In the province of Buenos Ayres there are 45,500,000 sheep, which give a yield of 136,500,000 ℔ unwashed wool; 5,116,000 cows; and 1,500,000 horses. This gives the unusual average of 200 sheep, 20 cows, and 6 horses to every inhabitant. The sheep-farms cover over 40,000,000 acres; and the number of shepherds may be estimated at 30,000, of whom at least a quarter are Irish or Scotch. The total value of exports from Buenos Ayres in 1872 was £9,148,638,—the most important being wool 203,610,000 ℔, sheep-skins 72,970,000 ℔, ox and cow-hides 3,121,758, jerked beef 916,220 qq., tallow 1,182,240 qq. The value of imports in 1872 may be stated approximately at £12,000,000, of which Great Britain contributed £3,800,000, France £3,200,000, Spain £800,000, Brazil £700,000, United States £700,000, Italy £600,000, Belgium £600,000, Germany £100,000, other countries £1,200,000.

Of the cereals grown in Buenos Ayres the most important is maize, which is indigenous to the country. Wheat thrives well in the southern parts of the province, but the inhabitants rarely grow more than enough to supply their own necessities. In the event of a surplus it is commonly exported to Brazil. The vine, fig, orange, and olive have been introduced from the Old World, and are found to suit the climate admirably; but the most valuable of European fruits is the peach. A considerable fruit trade is carried on in coasting vessels by merchants for the most part Italian or French.

The geographical position of Buenos Ayres is such as to enable it completely to control the foreign commercial relations of the entire republic of which it forms a part. The exclusive policy which it has always pursued on this point has often involved it in serious quarrels, not only with many of the South American states and the other provinces of the Argentine Republic, but with England and France. Since the expulsion of General Rosas, the navigation of the Parana and Uruguay has been thrown open, and other measures have been taken to place both the province and city of Buenos Ayres on a level with the other provinces of the republic.

The only towns of any importance, besides the capital, are San Nicolas, which is situated on the Parana, about 200 miles N.W. of Buenos Ayres, and contains a population of about 10,000; San Pedro, also on the Parana, about 150 miles from the capital, in the same direction, with a population of 1000; Chascomus, on a lake of the same name, a place of considerable importance; Dolores, 150 miles south of Buenos Ayres; Villa de Mercedes, Chivilcoy, Las Flores, and Belgrano.

Buenos Ayres, the capital of the Argentine Republic and of the province of Buenos Ayres, is situated on the right bank of the estuary of the La Plata, in 34° 39′ S. lat. and 58° 18′ W. long. The river is at this point so wide that it is quite impossible with the naked eye to distinguish the



Plan of Buenos Ayres.

A Recoleta Cemetery.
B Plaza Libertad.
C Plaza Marta or Del Retiro, and Statue of General San Martin
D Plaza del Parque.
E Arsenal.
F Plaza Lorea and Market.
G Plaza Victoria.
H Plaza de Mayo and the Arcades.
K Plaza Monserrat.
L Plaza Independencia.
M Mercado Constitucion and Railway Station.
N Mercado de Septiembre and Railway Station.
1. Barracks.
2. Railway Station.
3. Colisio Concert Hall.
4. Victoria Theatre.
5. University and Museum.
6. Colon Opera House.
7. Archiepiscopal Palace.
8. Cathedral.
9. Congress Hall.
10. Franco-Argentine Theatre.
11. Custom House and Government House.

opposite bank, and at the same time so shallow, that ships drawing 15 or 16 feet of water must anchor seven or eight miles from the city. Small craft generally anchor in what are called the inner roads, abreast of the city. The depth of water is never sufficient to admit of their coming to shore.

The town of Buenos Ayres is situated in a vast plain extending westwards to the Andes. The level uniformity of its outline is only broken by the spires of the various churches. The stranger, on landing, is struck with the

regularity of the streets, which are quite straight, and intersect each other at distances of 150 yards, forming squares like those of a chess-board, with the cleanly appearance of the houses, and the general air of independence that distinguishes the inhabitants. The houses till lately had never more than two stories, and commonly only one, the rooms of which open into each other, and were chiefly supplied with furniture of a very inferior description from the United States. A chimney was a thing unknown, and the old Spanish brazero alone was employed in heating the damp and white-washed rooms. A great change has, however, taken place in these respects within the last few years. A rage for building has prevailed, and now splendid edifices of three and four stories may be seen in every street. The furniture is now supplied from Europe, the walls are papered, grates and chimneys have come into fashion, and English coal is burned. These comforts are all the more valuable, as the climate of Buenos Ayres is one of the most humid and changeable in the world. The streets of the city are now tolerably paved with granite. They exceed eighty in number, thirty-one of them running from the river side due west, and fifty-one from north to south. The city is being provided with drainage and water supply, and is well lighted with gas. There are eleven parishes, containing sixteen Roman Catholic churches. There are two city hospitals, supported by the municipality, and four for foreigners, belonging to the English, French, Italian, and Irish communities. The theatres are five in number, and there is also a concert-hall. Five markets for the daily supply of the city with provisions are placed at convenient distances; and the *plazas* "11 de Setiembre" and "Constitucion," are the great wool markets for the north and south districts of the camp. Floriculture is a favourite pursuit; and many English and Scotch gardeners have nurseries in the neighbourhood of the town.

Of the public buildings may be noticed the Government house, which is situated on the beach, a residence for the president of the Republic; the cathedral, which is surmounted by a handsome dome, and has a large portico with twelve Corinthian pillars; the cabildo or town-house, in which justice is administered; the churches of La Merced, San Francisco, and San Domingo; and the custom-house. The Plaza de la Victoria, round which some of these edifices are grouped, is the handsomest square in Buenos Ayres. In the centre of it is a handsome monument, erected as a memorial of the War of Independence. When the number of British residents in the town began rapidly to increase application was made to General Rosas for a site for a church. This was immediately granted, and the minister for the time being set an example of liberality and toleration to his countrymen by laying the foundation-stone of the edifice, which cost in all about £4000, half of which was defrayed by the British Government. The Scottish residents have built a small Presbyterian chapel, and the Roman Catholic portion of the English subjects are allowed the use of one of the national churches, in which a priest performs the service. In 1842 the Methodists erected a meeting-house, which is used by all denominations of the British Dissenters. The Protestant Germans, who are pretty numerous, have a church in connection with the Established Church of Prussia. To each of these places of worship schools are attached for children of both sexes. The facilities for education are very considerable, and of these the inhabitants avail themselves extensively. Besides the denominational schools already alluded to, there is a university, attended by about 500 students, and possessing a valuable library. The sons of the wealthier families of the city are very frequently sent to Europe to complete their education at some of the great schools and colleges in France and England. The Buenos Ayreans inherit from their ancestors much of that passion for music which characterizes the Spaniard. Poetry also is much cultivated among them. Besides its university, Buenos Ayres contains many literary and scientific institutions. Of these the most important are the school of medicine, the academy of jurisprudence, a special academy of mathematics and the physical sciences, a normal school, and a society for the promotion of agriculture. The charitable societies, though not very numerous, are rather important. Spanish is the language spoken by the Buenos Ayrean descendants of the old Spanish settlers.

the defence of the country in the event of war, &c. While these internal dissentions were going on, war was declared between the young confederation and the empire of Brazil, and Buenos Ayres was blockaded for a year and a half by a Brazilian fleet. In 1828, however, the siege was raised by the intervention of the English, and by the decisive battle that took place at Ituzaingo favourable to the Argentine arms. This foreign war thus ended, the civil war broke out once more, and was only temporarily checked by the accession of General Rosas to power in 1835. Aiming at territorial aggrandizement, Rosas soon became involved in war with the neighbouring states of Paraguay and Uruguay. England, France, and Brazil interfered, with the intention of effecting an amicable arrangement between the belligerents. Rosas rejected their mediation; and the united fleets of England and France took possession of the Buenos Ayrean fleet which was engaged in the siege of Monte Video, and opened the navigation of the Parana to the merchantmen of all nations. In the subsequent operations Rosas sustained severe losses, yet obstinately refused to yield. In 1848 the English fleet returned home, and was followed by the French in the following year. Brazil was now left to carry on the war alone, but she found ready allies in some of the provinces of the Argentine Confederation, which had long regarded with hatred and aversion the supremacy arrogated by Buenos Ayres. With the assistance of these and the adjoining states of Uruguay and Paraguay, a large army was raised, which, under the command of General Urquiza, defeated Rosas at the battle of Monte Caseros, February 3, 1852. Rosas after his downfall fled to England. Urquiza was appointed provisional director of the confederation; but the Buenos Ayreans protested against his policy, which threatened to undermine the prerogatives they had been long struggling to secure. Civil war again broke out; and in 1853 Buenos Ayres was besieged by the forces of the other states of the confederation. On the 20th of June the siege was raised, and a temporary accommodation effected.

Since the establishment of the Argentine Republic in 1861 the city and province of Buenos Ayres have both very considerably developed their resources. In the province there are now 450 miles of railway, and 2228 miles of telegraph lines; in the city there are six lines of tramway, which traverse the town in every direction. Most of the railways and three of the tramway lines belong to English companies. There are thirteen different lines of steamers trading between Europe and the Port of Buenos Ayres. Population (1876) estimated at about 220,000.

BUFFALO, the English name of *Bubalus*, a genus of Ruminant Mammals, belonging to the family *Bovidæ*, and including the well-known Indian and South African species. The Indian Buffalo (*Bubalus buffalus*) is characterized by its arched forehead, large horns compressed at the base, slightly triangular, and curved in the form of a half moon, and its thick hide covered sparingly with coarse hairs, which become still more scanty in aged individuals. It is a native of India and of the islands forming the Indo-Malay Archipelago, where it now occurs in a state of domestication, and forms a valuable beast of burden; but although it has for ages been under the control of man, the *Bainsha* or tame buffalo shows little or no variation from the wild form. The *Arna* or Wild Buffalo is found in great herds throughout India and the adjacent islands, frequenting swampy grounds in the neighbourhood of woods, eating the long, coarse grass which abounds in such localities, and loving above all things to roll itself in mire, or to plunge up to the ears in any pool or stream it may come upon. This fondness for moisture is equally marked in the tame variety, and is decidedly inconvenient when the animal, laden with goods, yields to its instinct and lies down in any stream that may cross its path. The rutting season occurs in autumn, when several females follow a single male, forming for the time a small herd. The period of gestation lasts for ten months, and the female produces one or two calves at a birth. The *Arna* is a powerful and courageous animal, capable it is said of overthrowing an elephant, and generally more than a match even for the male tiger, which usually declines the combat when not impelled to it by hunger. The Indian driver of a herd of tame buffaloes does not shrink from entering a tiger-frequented jungle, his cattle, with their massive horns, making short work of any tiger that may come in their way. Buffalo fights and fights between buffaloes and tigers form principal features in the public entertainments of Indian princes. In Ceylon the buffalo is put to more useful purposes, where, according to Tennent, the natives make an ingenious use of it when shooting waterfowl in the salt marshes. "Being an object to which the birds are accustomed, the Singhalese train the buffaloes to the sport, and concealed behind the animal, browsing listlessly along, they guide it by ropes attached to its horns, and thus creep undiscovered within shot of the flock." These are known as "sporting buffaloes." The domestic buffalo has spread from its original home in India over the greater part of Southern Asia and of North Africa, and was introduced towards the close of the 6th century into Greece and Italy, forming an invaluable beast of burden in the marshy districts of those countries, where the great breadth of its feet, somewhat resembling in this respect those of the reindeer, give it a decided advantage over the horse and ox. It grazes in herds in the Pontine marshes, where, according to Scaliger, it will lie for hours submerged almost to the muzzle. The milk of the buffalo is plentiful and of excellent quality, the Hindoos making it into a kind of butter called *ghee*; its flesh, however, is not held in much estimation.

The Cape Buffalo (*Bubalus caffer*) is nearly equal in size and fully equal in strength and courage to its Indian congener, from which it is readily distinguished by the form of its horns, these being immensely broad at the base, where they approximate so closely as almost to meet, thus forming, especially in old bulls, a solid rugose mass impenetrable to bullet, and extending from the eye to the back of the head, then spreading horizontally and curving upwards and inwards to the tips, which are usually 4 feet apart. The hide, which is thick and tough, is thinly clad with hair, old animals being entirely naked with the exception of a slight fringe along the back and withers. This buffalo roams in herds over the plains of Central and Southern Africa, always in the near vicinity of water. Formerly herds sometimes numbered five or six hundred, but such has been the havoc wrought among them in recent years by hunters that rarely are they to be seen in companies of more than ten, while in the colonized portion of South Africa they are rapidly dying out. Nor is man their only enemy, for by night when he ceases to disturb they are liable to the attack of the lion, and by this means the wounded, of which there are great numbers, and the diseased are cut off. The Hon. W. H. Drummond, in his work on *The Large Game of South Africa* (1875), gives it as his opinion that in "a few years a buffalo will be as scarce as an elephant now is." This species has never been domesticated, probably owing more to the uncivilized condition of the native inhabitants than to any special intractability in the buffalo itself. Like its Indian ally it is fond of the water, which it visits at regular intervals during the twenty-four hours; it also plasters itself with mud which, when hardened by the sun, protects it from the bite of the great gadflies which in spite of its thick hide seem to cause it considerable annoyance. It is also relieved of a portion of the parasitic ticks, so common on the hides of thick-skinned animals, by means of the red-beaked rhinoceros birds, a dozen or more of which may be seen partly perched on its horns and partly moving about on its back, and picking up the ticks on which they feed. The hunter is often guided by these birds in his search for the buffalo, but oftener still they give timely warning to their host of the dangerous proximity of the hunter, and have thus earned the title of "the buffalo's guardian birds." The Cape Buffalo is the most formidable of the large game of South Africa. Generally, however, it attacks only when wounded, although "rogues" or "solitaires"—terms applied to old bulls which for some reason or other have been expelled from the herd and which wander about morose and savage— often attack without

provocation. When wounded they immediately charge in the direction from which the fire proceeded, and on his skill in avoiding this charge the life of the hunter depends. In buffalo hunting, as in bison hunting, it is specially important "to kill with a single bullet." The hide of the Cape Buffalo is made by the Kaffres into shields impervious to musket shot.

BUFFALO, an American city, the capital of Erie County, in the State of New York, U.S., about 293 miles N.W. from New York, in 42° 53' N. lat. and 78° 55' W. long. It is a port at the east end of Lake Erie, at the mouth of Buffalo River, and at the head of Niagara River, which is here crossed by a fine iron railroad bridge. The city runs for about five miles along the shore of the lake and Niagara River. In population Buffalo is the third city in New York, and the eleventh in the United States. It was founded in 1801, became a military post in 1813, and was burned by the British on the last day of the year 1813. After the war, the place was rebuilt, and in 1832 it attained the rank of a city. In 1820 it contained 2095 inhabitants. After the opening of the Erie Canal in 1825, its growth was rapid, the population being 8653 in 1830, 18,213 in 1840, 42,261 in 1850, 81,129 in 1860, 117,714 in 1870, and 134,238 in 1875. The city commands a fine view of the lake; the climate is pleasant and healthful; the streets, broad and generally lined with trees, are well paved, lighted, and supplied with sewers. There are many fine residences with attractive grounds, and numerous squares and public places. A combination of parks or pleasure grounds has been laid out, extending to over 500 acres. It comprises three sections, situated respectively in the northern, western, and eastern parts of the city, connected by boulevards which together afford a drive of nearly 10 miles. The most prominent public buildings are the City and County Hall, a granite structure, in the form of a double Roman cross, with a tower 245 feet high, just erected at a cost of over $2,000,000; the United States Custom House and Post Office, the State Arsenal, and the Erie County Penitentiary, which is one of the six penal establishments of New York, intermediate between the reformatories and the state prisons. A state asylum for the insane is in process of construction at North Buffalo, with a front of about 2700 feet and a capacity for 600 patients. It will be one of the largest institutions of the kind in the United States, and will cost not less than $3,000,000. The city contains 76 churches, the most imposing edifices being St Joseph's Cathedral (Roman Catholic) and St Paul's (Episcopal). The public schools comprise a central grammar school and thirty-six district schools. Four orphan-asylum schools are also maintained. One of the eight state normal schools is situated here. Among other educational institutions are Canisius College, founded by the Jesuit fathers; St Joseph's College, conducted by the Christian brothers; Martin Luther College (theological); St Mary's Academy and Industrial School for girls, and the Medical College of the University of Buffalo. The charitable institutions of the city are numerous. There are several libraries, the most important being that of the Young Men's Association, with about 30,000 volumes, and the Grosvenor Free Library, which contains about 15,000 volumes of valuable reference works. The former society has a commodious hall and library building adjoining. The Society of Natural Sciences has made an extensive collection of minerals and fossil casts, and the Buffalo Historical Society has a large library and cabinet. There are published in the city eight daily newspapers, including four in German, one tri-weekly, fourteen weeklies, four monthlies, and three quarterlies. The city is divided into thirteen wards, and is governed by a mayor and twenty-six aldermen. It has a paid fire department, with steam fire-engines and a fire-alarm telegraph, has an efficient police, and is well supplied with water from the Niagara River. The assessed value of property in 1873 was about $38,000,000.

The position of Buffalo on the great water and railway channels of communication between the West and the East gives it a commercial importance surpassed by that of few other American cities. Its harbour is capacious, and is protected by extensive breakwaters. The city is the centre of an important system of railroads. Besides other lines which converge here, it is the eastern terminus of the Lake Shore and Michigan Southern Railway, of the Canada Southern, and of a branch of the Grand Trunk Railway of Canada; it is the western terminus of the Erie Canal, the New York Central Railway, and a division of the Erie Railway. There has been a large decrease in the extent of the lake commerce since 1862, owing to the increase of railroad facilities. The registered marine of the port, June 30, 1874, comprised 801 vessels of 162,789 tons, of which 533 were canal boats. The annual value of the imports from Canada is between $2,000,000 and $3,000,000; the exports are less than $500,000. Since 1870 Buffalo has been a port of foreign entry for imports, which are conveyed thither, in bond, by rail from New York, &c. The number of lake vessels that arrived in 1874 was 3720; the clearance numbered 3727; 7643 canal boats arrived, and about the same number cleared; the latter carried 1,448,172 tons of freight, valued at $46,244,875. The immense quantities of grain moving from the Western States to the seaboard constitute the most important feature of the commerce of the city. The aggregate receipts (including flour) by lake and Grand Trunk and Canada Southern Railways in 1874 were 70,030,555 bushels. The receipts during the ten years ending with 1874 amounted to 522,874,944 bushels. For receiving, storing, and transferring this vast amount of produce to canal boats and railway cars, there are thirty elevators, capable together of storing 6,875,000 bushels, and of transferring no less than 2,672,000 bushels a day. Many of these elevating warehouses are costly structures of stone, or of iron and brick. Several of them have grain "driers" attached. Live-stock and lumber from the Western States and Canada, and coal from Pennsylvania, are also leading items in commerce. In 1874, 504,594 cattle, 783,800 sheep, 1,431,800 hogs, and 21,937 horses, amounting in value to nearly $60,000,000 passed through Buffalo. For the accommodation of this traffic, extensive and well-arranged yards have been erected at the east end of the city. The receipts of lumber by lake in 1874 amounted to 145,624,639 feet, besides about 40,000,000 shingles, and 25,000,000 staves. The imports of coal comprised 800,000 tons. The coal trade is rapidly increasing. The manufacturing interests of Buffalo are extensive, and have grown with marked rapidity in recent years. The leading establishments are blast furnaces, rolling-mills, foundries, breweries, tanneries, manufactories of agricultural implements, and flour-mills. Of the last-named there are eleven, with a yearly capacity of 830,000 barrels, the average annual production of flour being about 250,000 barrels. Wooden ship-building was formerly carried on here, but it has been superseded by iron ship-building. Two extensive establishments are devoted to this industry; these have constructed the finest lake steamers, besides supplying the Government with a number of iron revenue vessels. The number of ships built at Buffalo in 1874 was thirty-one, but they were mostly small ones. Many canal boats are

Poland May 25, 1661, of French parents, who returned to their native country shortly after their son's birth, and settled at Rouen. He was educated at the Jesuits' college there, and was received into the order at the age of nineteen. Soon after his admission a dispute with the archbishop regarding certain points in theology compelled him to leave Rouen. He went to Rome, but did not long remain there; and on his return to France he retired to the college of the Jesuits at Paris, where he spent the rest of his life, studying and writing, and fulfilling with much success his duties as a college lecturer. He seems indeed to have been an admirable teacher, having, as his works show, a great power of lucid and precise exposition. Buffier's object in his *Traité des vérités premières*, his best known philosophical work, is to discover the ultimate principles upon which all knowledge is based, to lay down "propositions so clear and obvious that they can neither be proved nor refuted by other propositions of greater perspicuity." The basis of all human knowledge and the foundation of every other truth he finds in the sense we have of our own existence and of what we feel within ourselves. He thus takes as the foundation of his philosophy substantially the same ground as Descartes, *cogito ergo sum;* but the superstructure is reared on very different principles. Descartes tried to reach a knowledge of the not-self by an *a priori* or metaphysical proof of the divine existence. Buffier rejects this sort of evidence as useless. I want, he in effect says, to obtain a certain knowledge of what is distinct from myself, and this I can never do by mere metaphysical demonstration, which only gives me the hypothetical certainty of ideas logically connected together; in order to know what exists distinct from myself I must have recourse to "common sense." Common sense he defines to be "that disposition which nature has placed in all or most men, in order to enable them, when they have arrived at the age and use of reason, to form a common and uniform judgment with respect to objects different from the internal sentiment of their own perception, which judgment is not the consequence of any anterior principle." The truths which this "disposition of nature" obliges us to accept can neither be proved nor disproved; they are admitted in all countries and at all times; and they are practically followed by all men, even by those who reject them speculatively. But Buffier does not claim for the truths of common sense the same absolute certainty as characterizes either the knowledge we have of our own existence or the logical deductions we make from our thoughts; they possess merely the highest probability, and the man who rejects them is, as he pointedly puts it, to be considered a fool, but he is not in so doing guilty of a contradiction. The greater part of the *Traité* is devoted to an enumeration and examination of those truths. They are such as the following:—"There are other beings and other men in the world besides myself;" "All men have not combined to deceive me." But axioms like "2 + 2 = 4," or "the whole is greater than a part" are mere logical connections of ideas, not truths of common sense. Buffier's aversion to scholastic refinements and unmeaning definitions has not unfrequently given to his writings an appearance of shallowness and want of metaphysical insight; but his merit as one of the earliest to recognize the psychological as distinguished from the metaphysical side of Descartes's principle, and to use it, with no inconsiderable skill, as the basis of an analysis of the human mind, similar to that enjoined by Locke, will always be acknowledged. In this he has anticipated the spirit and method as well as many of the results of Reid and the Scotch school. The *Traité* appeared in 1717, and was followed in 1724 by the *Eléments de Métaphysique*. Buffier also wrote a "French Grammar on a new plan," and a number of historical essays. Most of his works appeared in a collected form in 1732, and an English translation of the *Traité* was published in 1780.

BUFFON, GEORGE LOUIS LECLERC, COMTE DE, was born on 7th September 1707, at Montbard, in Burgundy, and died at Paris on the 15th April 1788. His father, M. Leclerc de Buffon, was councillor of the Burgundian parliament, and his mother, Anne Christine Marlin, appears to have possessed considerable natural gifts. Buffon was the eldest of five children, and does not seem to have been in any way a precocious child. On the contrary, he seems from his earliest years to have been characterized more especially by great perseverance, patience, knowledge of the value of time, and exceptional powers of steady application and protracted labour. He was originally destined to his father's profession, and studied law at the college of Jesuits at Dijon; but he soon exhibited a marked predilection for the study of the physical sciences, and more particularly for mathematics. Whilst at Dijon he made the acquaintance of Lord Kingston, a young Englishman, who was at the time staying there along with his tutor, a man of ability and discernment. In this agreeable companionship, Buffon travelled through Italy, being then nineteen years of age. Returning to France, he commenced to study at Angers, still in company with Lord Kingston; but having quarrelled with a young Englishman at play, and subsequently wounded him, he was compelled to leave this town. He thereupon removed to Paris, and during his sojourn in the capital he translated Newton's *Fluxions* and Hales's *Vegetable Statics*, which he subsequently presented to the Academy of Sciences. From Paris he proceeded to England, where he remained three months; but his travels seem to have ended here. At twenty-five years of age he succeeded to a considerable property, inherited from his mother, and from this time onward his life was a completely independent one, and he was enabled to devote himself entirely to his scientific pursuits. He returned now to France, and lived partly at Montbard and partly at Paris.

Though loving pleasure, and not keeping himself free from the prevalent vices of the age in which he lived, Buffon spent the remainder of his life in regular scientific labour, employing an amanuensis, and thus securing a permanent record of his work. At first he directed his attention more especially to mathematics, physics, and agriculture, and his chief original papers are connected with these subjects. In the spring of 1739 he was elected a member of the Academy of Sciences; and at a later period of the same year he was appointed keeper of the *Jardin du Roi* and of the Royal Museum. This appears to have finally determined him to devote himself to the biological sciences in particular, and he commenced to collect materials for his *Natural History*. In the preparation of this voluminous work, he associated with himself Daubenton, to whom the descriptive and anatomical portions of the treatise were entrusted, and the first three volumes made their appearance in the year 1749. In the year 1752 (not in 1743 or 1760, as sometimes stated), he married Marie Françoise de Saint-Belin. He seems to have been fondly attached to her, and felt deeply her death, which took place at Montbard in 1769. The remainder of Buffon's life, as a private individual, presents nothing of special interest. He belonged to a very long-lived race, his father having attained the age of ninety-three, and his grandfather eighty-seven years. He died himself at the age of eighty-one, of vesical calculus, having refused to allow of any operation for his relief. He left one son, George Louis-Marie Leclerc, who was an officer in the French army, and who died by the guillotine, at the age of thirty, on the 10th July 1793 (22 Messidor, An II.), having espoused the party of the duke of Orleans.

Buffon was a member of the French Academy, perpetual treasurer of the Academy of Sciences, Fellow of the Royal Society of London, and member of the Academies of Berlin, St Petersburg, Dijon, and of most of the learned societies then existing in Europe. Of handsome person and noble presence, endowed with many of the external gifts of nature, and rejoicing in the social advantages of high rank and large possessions, he is mainly known by his published scientific writings. Without being a profound original investigator, in the modern sense of this term, Buffon possessed considerable power of generalization, along with the art of expressing his ideas in a clear and generally attractive form. His chief defects as a scientific writer are, that he was given to excessive and hasty generalization, so that his hypotheses, however seemingly brilliant, are often destitute of any sufficient basis in observed facts, whilst his literary style is not unfrequently theatrical and turgid, and a great want of method and order is commonly observable in his writings.

His great work is the *Histoire Naturelle, générale et particulière;* and it can undoubtedly claim the merit of having been the first work to present the previously isolated and apparently disconnected facts of natural history in a popular and generally intelligible form. The sensation which was made by its appearance in successive parts was very great, and it certainly effected much good in its time by generally diffusing a taste for the study of nature. For a work so vast, however—aiming, as it did, at being little less than a general encyclopædia of the sciences,—Buffon's capacities may, without disparagement, be said to have been insufficient, as is shown by the great weakness of parts of the work (such as that relating to mineralogy). The *Histoire Naturelle* passed through several editions, and was translated into various languages. The edition most highly prized by collectors, on account of the beauty of its plates, is the first, which was published in Paris (1749-1804) in forty-four quarto volumes, the publication extending over more than fifty years. In the preparation of the first fifteen volumes of this edition (1749-67) Buffon was assisted by Daubenton, and subsequently by Guéneau de Montbéliard, the Abbé Bexon, and Sonnini de Manoncourt. The following seven volumes form a supplement to the preceding, and appeared in 1774-89. These were succeeded by nine volumes on the Birds (1770-83), and these were followed by five volumes on Minerals (1783-88). The remaining eight volumes, which complete this edition, appeared after Buffon's death, and comprise Reptiles, Fishes, and Cetaceans. They were executed by Lacépède, and were published in successive volumes between 1788 and 1804. A second edition was commenced in 1774 and completed in 1804, in thirty-six volumes quarto. It is in most respects similar to the first edition, except that the anatomical descriptions are suppressed, and the supplement recast. Of the remaining editions of Buffon, the best is that which was commenced under the editorship of Lamouroux, and completed under that of Desmarets, in forty volumes octavo (1824-32). It is the only modern edition in which the anatomical descriptions of Daubenton are preserved. Though not without his enemies—scientific and clerical—Buffon had many warm friends, and his death was marked by the delivery of highly laudatory addresses, by Condorcet at the Academy of Sciences, Vicq-d'Azir at the Académie Française and Bressonet before the Society of Agriculture. Extravagantly belauded by some, and vehemently attacked by others, we can recognize his merits without blinding ourselves to his defects.

This brief notice of his life may be fitly closed by the following quotation from Cuvier, in which the great French naturalist, whilst rejecting some speculations which recent science has generally accepted as probable, ascribes to Buffon the honour of being the first to clearly apprehend what is now admitted as the true principle of guidance in investigating the order of the universe:—"It is impossible to defend, in all their details, either the first or the second of Buffon's theories of the earth. This comet which strikes off portions of the sun, these vitrified and incandescent planets which refrigerate by degrees, some more rapidly than others, those organized beings which appear successively on the surface of the planets, as their temperature becomes sufficiently lowered, can only be regarded as flights of fancy. But Buffon has not less the merit of having been the first to point out clearly that the actual condition of the globe is the result of a succession of changes, of which we can find the evidences to-day; and it is he who first drew the observation of all investigators to the phenomena by which these changes can be unravelled." (H. A. N.)

BUG, a name common to all the species belonging to the *Cimicidæ*, a family of Hemipterous Insects, the best known example of which is the House Bug or Bed Bug (*Cimex lectularius*). This disgusting insect is of an oval shape, of a rusty red colour, and, in common with the whole tribe to which it belongs, gives off an offensive odour when touched; unlike the others, however, it is wingless. The bug is provided with a proboscis, which when at rest lies along the inferior side of the thorax, and through which it sucks the blood of man, the sole food of this species. It is nocturnal in its habits, remaining concealed by day in crevices of bed furniture, among the hangings, or behind the wall paper, and shows considerable activity in its nightly raids in search of food. The female deposits her eggs at the beginning of summer in crevices of wood and other retired situations, and in three weeks they emerge as small, white, and almost transparent larvæ. These change their skin very frequently before undergoing metamorphosis, which in their case is "incomplete," the pupa closely resembling the perfect insect, and attaining its full development in eleven weeks. Two centuries ago it was a rare insect in Britain, and probably owes its name, which is derived from a Celtic word signifying "ghost" or "goblin," to the terror which its attacks at first inspired. Other species of bugs suck the blood of

BUGULMA, a town of European Russia, in the government of Samara, 243 miles from the city of that name, on the small river Bugulminka, a sub-tributary of the Volga, in 54° 32′ N. lat. and 52° 47′ E. long. The town rose into existence about 1741–5, and was peopled by soldiers, exiles, and peasants. During the Pugacheff insurrection it was vainly besieged by the rebels. In 1781 it was made a town of the Ufa government; in 1806 it was transferred to Orenburg, and in 1851 to Samara. Its principal importance is derived from its situation at the junction of two great roads from Ufa and Orenburg, by which it maintains an extensive transit trade. A great annual fair is held from 14th to 21st of September (o. s.). Population in 1867, 5455.

BUGURUSLAN, a town of European Russia in the government of Samara, situated at the junction of the rivers Kinell and Tarkhanka, 177 miles E.N.E. of Samara, in 53° 39′ N. lat. and 52° 25′ E. long. It dates from about 1748, and in the time of the Pugacheff revolt was the scene of the outrages of Karpoff's band. Its changes from government to government coincide with those of Bugulma. The principal buildings are two or three churches, a monastery, a hospital, and a caravanserai. It manufactures leather, wax, potash, and beer, and carries on a pretty extensive trade. There are two annual fairs. Population in 1867, 7450.

BUHLE, JOHANN GOTTLIEB (1763–1821), distinguished as a scholar and an historian of philosophy, was born at Brunswick, and graduated at the university of Göttingen, where he obtained a chair at a very early age. Thence he was called to the professorship of ancient languages at Moscow. After his return to Brunswick he was appointed to the chair of natural law, which he held till his death in 1821. Buhle's activity was great, and the productions of his pen are numerous. He edited *Aratus* and part of *Aristotle* (the Bipontine edition, 5 vols.), the first volume of which is a masterly survey of Aristotelian literature. His fame, however, is principally derived from his labours on the history of philosophy. The *Geschichte der philos. Vernunft*, 1793, was suspended after the first volume, but the *Handbuch der Geschichte der Philosophie*, 8 vols. 1796–1804, is a very complete and valuable work. More important than either of these is the *Geschichte der neuern Philosophie*, forming one of the great series of histories of the sciences from the Renaissance. It is a work of much learning, and is well written; its faults are general weakness in critical appreciation and want of due sense of proportion. The *History of Modern Philosophy* has been translated into French, 6 vols. 1806.

BUHL-WORK, otherwise Bool, Boule, or Boulle-work, is a kind of inlaying and ornamentation of cabinet-work, so named after the inventor André Charles Boule, a celebrated French cabinetmaker (1642–1732) By a happy selection of different woods from India and Brazil, arranged with great taste, and the use of brass, ivory, gold, tortoise-shell, &c., Boule produced upon his furniture arabesques and pictures, representing a variety of animals, flowers, and fruits; and he finally succeeded in producing historical scenes, as battles and hunts, landscapes, and other artistic effects. Louis XIV. appreciated his abilities, gave him lodgings in the Louvre, and, in 1672, appointed him engraver in ordinary of the royal seals. In the patent authorizing this he received also the designations of "architect, painter, carver in mosaic, artist in cabinet-work, chaser, inlayer, and designer of figures." His skill was great in all these branches, and he carried them to a high degree of artistic perfection in timepieces, screens, furniture, and other articles. He worked for the royal residences and for foreign princes, and attained fortune and position.

The beginnings of art in carving are found amongst the relics of prehistoric races, and when it arrived at the degree of perfection it afterwards attained in the East, inlaying was a natural result. We find this to have been practised by the ancient Egyptain and other Asiatic races. Its attendant, veneering, was also employed by them, workmen applying the veneer with glue being represented on the Egyptian monuments. As civilization advanced westward, the Greeks and Romans followed in the art, the latter race inlaying their furniture with marquetry or tarsia-work, using ivory, ebony, box, palm, bird's-eye maple, beech, and other woods. Their bronze articles they damascened with ornaments of the precious metals and metallic amalgams. The spirit of the Middle Ages was adverse to the development of this art, and but few traces of it are found. In the South Kensington Museum is a coffer of cypress, with flat surface imagery filled in with coloured wax composition, that dates from the 14th century. The Venetians derived their marquetry from Persia and India, as is indicated by the geometric patterns inlaid with ivory, metal, and woods, stained of various colours. Florence took a prominent place in this manufacture in the 15th century. Certosina-work was the result; it was so called from the great Certosa, Charterhouse, or Carthusian monastery, between Milan and Pavia, in the choir-fittings of which this kind of ornament, ivory inlaid into solid cypress and walnut wood, is employed. Work in the Persian style, with its geometric figures, still reaches us from Bombay, the present great seat of the Parsees.

The Renaissance artists chiefly employed wood in making furniture, ornamenting it with gilding and painting, and inlaying it with agate, carnelian, lapis-lazuli, marble of various tints, ivory, tortoise-shell, mother-of-pearl, and various woods. Boule improved upon this by inlaying brass devices into wood or tortoise-shell, which last he greatly used according to the design he had immediately in view, whether flowers, scenes, scrolls, &c.; to these he sometimes added enamelled metal. In this process the brass is thin, and, like the ornamental wood or tortoise-shell, forms a veneer. In the first instance the production of his work was costly, owing to the quantity of valuable material that was cut away and wasted, and, in addition, the labour lost in separately cutting for each article or copy of a pattern. By a subsequent improvement Boule effected an economy by gluing together various sheets of material and sawing through the whole, so that an equal number of figures and matrices were produced at one operation. Boule adopted from time to time various plans for the improvement of his designs. He placed gold-leaf or other suitable material under the tortoise-shell to produce such effect as he required; he chased the brass-work with a graver for a like purpose, and, when the metal required to be fastened down with brass pins or nails, these were hammered flat and disguised by ornamental chasing. He also adopted, in relief or in the round, brass feet, brackets, edgings, and other ornaments of appropriate design, partly to protect the corners and edges of his work, and partly for decoration. He subsequently used other brass mountings, such as claw-feet to altars and pedestals, or figures in high or low relief, according to the effect he desired to produce. Boule's contemporary, Reisner, a German, used a variety of woods, tulip-wood more especially, in the production of flowers and other ornamental designs, contrasting the dark with the light kinds, crossing the grain, and employing other ingenious devices. After him this particular style was called Reisner-work. The Spaniards of the 16th century used silver for inlaying.

See *Grande Dictionnaire Universel du XIXe siècle*; Pierer's *Universal-Lexikon*, Altenberg, 1868; *Encyclopédie des Gens du Monde*; Bemrose's *Buhl-work and Marquetry*, a very useful manual; Pollen's *Furniture and Wood-work*.

BUILDING

lation of ilding archi- ture.

THE art of building comprises the practice of civil architecture, or the mechanical operations necessary to carry the designs of the architect into effect. It is not unfrequently called *practical architecture;* but the adoption of this term would tend only to confuse, by rendering it difficult to make the distinction generally understood between architecture as a fine or liberal art and architecture as a mechanical art. The execution of works of architecture necessarily includes building, but building is frequently employed when the result is not architectural; a man may be a competent builder without being an architect, but no one can be an accomplished architect unless he be competent to specify and direct all the operations of building. A scientific knowledge of the principles of masonry, carpentry, joinery, &c., and of the qualities, strength, and resistance of materials, though of the utmost importance to an architect, must be attended by a minute acquaintance with a great variety of less ambitious details. Such are those which relate to the arrangement of a plan for the greatest possible degree of convenience on the smallest space, and at the least expense; its transference to the ground; the preparation and formation of foundations; the arrangement and construction of drains, sewers, and vent-shafts; the varieties of walling with stone, and of laying bricks in brickwork; the merit of the various modes of bonding and tying walls, both lengthwise and across; the arrangement of gutters on roofs, to get sufficient fall, and to conduct the water to the least inconvenient places for fixing trunks to lead it down; the arrangement and formation of flues; the protection of walls from damp, of timber from moisture and stagnant air, and of metals generally from exciting causes; the cost of materials and labour, and the quantity of each required to produce certain results. Together with these, an architect ought to be practically acquainted with all the modes of operation in all the trades or arts employed in building, and to be able minutely to estimate beforehand the absolute cost involved in the execution of a proposed structure. The power to do the latter necessarily involves that of measuring work, and ascertaining the quantities done. These things may certainly be referred to the surveyor or measurer, but they are not the less incumbent on the architect, who cannot be said to be thoroughly master of building, or the practice of his profession, unless he be skilled in these operations.

Building includes what is called construction, which is the branch of the science of architecture relating to the practical execution of the works required to produce any structure; it will therefore be necessary to explain the subject in a general manner before entering upon building in detail.

It may, perhaps, be useful to premise that, should it occur to some readers that the present article has too great a tendency to supply information on the manner of building in a modern style, and that the earlier method is not elaborated, it must be remembered that, although the styles of architecture have varied at different periods, buildings, wherever similar materials are employed, must be constructed on much the same principles. Greater scientific knowledge of the natures and properties of materials has, however, given to the modern workman immense advantages over his mediæval brother craftsman, and caused many changes in the details of the trade, or art of building, although stones, bricks, mortar, &c., then as now, formed the element of the more solid parts of all edifices. The introduction of fir, too, in place of the more solid and durable timber oak, has likewise occasioned similar changes, too numerous to mention in detail, in the sister arts of carpentry and joinery, probably also causing the division of the carpenter's trade of the mediæval period. Certain exceptional features of mediæval work did exist, and most, if not all, will, it is hoped, be found referred to in this article.

General Principles of Construction.

Stabil the ol of con struct Wall.

The object of construction is to adapt and combine fit materials in such a manner that they shall retain in use the forms and dispositions assigned to them. If an upright wall be properly constructed upon a sufficient foundation, the combined mass will retain its position, and bear pressure acting in the direction of gravity, to any extent that the ground on which it stands and the component materials of the wall can sustain. But pressure acting laterally has a necessary tendency to overturn a wall, and therefore it will be the aim of the constructor to compel, as far as possible, all forces that can act upon an upright wall to act in the direction of gravity, or else to give it permanent means of resistance in the direction opposite to that in which a disturbing force may act. Thus when an arch is built to bear against an upright wall, a buttress or other counterfort is applied in a direction opposed to the pressure of the arch. Arch. In like manner the inclined roof of a building, spanning from wall to wall, tends to thrust out the walls; and hence a tie is applied to hold the opposite sides of the roof together at its base, where alone a tie can be fully efficient, and thus the roof is made to act upon the walls wholly in the direction of gravity; or where an efficient tie is inapplicable, buttresses or counterforts are added to the walls, to enable them to resist the pressure outwards. Roof. A beam laid horizontally from wall to wall, as a girder to carry a floor and its load, may sag or bend downwards, and tend thereby to force out the walls; or the beam itself may break. Beam. Both these contingencies are obviated by trussing, which renders the beam stiff enough to place its load on the walls in the direction of gravity, and strong enough to carry it safely. Or if the beam be rigid in its nature, or uncertain in its structure, or both (as cast-iron is), and will break without bending, the constructor, by the smith's art, will supply a check and ensure it against

in his works if he makes them dependent upon wrought iron. Cast-iron is brittle, and may not be exposed with impunity to transverse strain, especially if such strain be attended by action tending to induce vibration; it expands and contracts under the influence of heat, but it resists compression in every direction, and if used in small bodies, is valuable as a means of connecting other materials. Timber, being practically unchangeable in the direction of its length from the mere absorption of either heat or humidity, and at the same time practically both inextensible and incompressible in that direction, and being also readily wrought and easily combined alike with other timber and with iron, is a valuable material in the hands of the constructor; but it shrinks and swells in the direction of its thickness, and, in consequence, is subject to rapid decay when exposed to alternations of moisture and dryness; and although in many varieties timber is perdurable and unchangeable in form if it be kept either altogether free from moisture or always wholly wet, its quality of inextensibility is greatly diminished in value to the constructor on account of the comparatively slight resistance it offers to compressing power, and the comparative ease with which its fibrous structure is torn asunder. From this cause it cannot be grasped or otherwise held so that its power of resisting extension may be made available in any degree proportioned to its strength; whilst its quality of incompressibility in the opposite direction is of less value to the constructor for many purposes which require that quality in the material, because it absorbs moisture by the ends of the fibre more readily, and with a far more mischievous effect, than it does in the direction in which it is compressible. Hence timber rots more rapidly by the ends than by the sides.

Stone and brick, the other main available materials in general construction, keep their places in combination by means of gravity. They may be merely packed together, but in general they are compacted by means of mortar or cement, so that although the main constituent materials are wholly incompressible, masses of either or of both combined in structures are compressible until the setting medium has indurated to a like condition of hardness. That kind of stone is best fitted for the purposes of general construction which is least absorbent of moisture, and at the same time free to work. Absorbent stone exposed to the weather rapidly disintegrates; and for the most part non-absorbent stone is so hard that it cannot always be used with a due regard to economy. When, therefore, fitting stone of both qualities can be obtained, the harder stone can be exposed to the weather, or to the action which the softer stone cannot resist, and forms the main body of the structure of the latter so protected. The hard and the soft should be made to bear alike, and should therefore be coursed and bonded together by the mason's art, whether the work be of stone wrought into blocks and gauged to thickness, or of rough dressed or otherwise unshaped rubble compacted with mortar.

Good bricks are less absorbent of moisture than any stone of the same degree of hardness, and are better non-conductors of heat than stone. As the basis of a stable structure, brickwork is more to be relied upon than stone in the form of rubble, when the constituents bear the relation to one another last above referred to, the setting material being the same in both; because the brick, by its shaped form, seats itself truly, and produces by bonding a more perfectly combined mass; whilst the imperfectly shaped and variously sized stone as dressed rubble can neither bed nor bond truly,—the inequalities of the form having to be compensated for with mortar, and the irregularity of size of the main constituent accounted for by the introduction of larger and smaller stones. The most perfect stability is to be obtained, nevertheless, from truly wrought and accurately seated and bonded blocks of stone, mortar being used to no greater extent than may be necessary to exclude wind or water, to prevent the disintegrating action of both upon even the most durable stone. When water alone is to be dealt with, and especially when it is liable to act with force, mortar is necessary for securing to every block in the structure its own full weight and the aid of every other collateral and super-imposed stone in order to resist the loosening effect which water in powerful action is sure to produce.

Particular objects of construction. In the application of construction to any particular object, the nature of the object will greatly affect the character of the constructions and the materials of which they are to be formed.

Each complete in itself. Every piece of construction should be complete in itself, and independent as such of everything beyond it. A door or a gate serves its purpose by an application wholly foreign to itself; but it is a good and effective or a bad and ineffective piece of construction, independently of the posts to which it may be hung. Whilst the wheel of a wheelbarrow, comprising fellies, spokes, and axle-tree, is a piece of construction complete in itself, and independent as such of everything beyond it, an arch of masonry, however large it may be, is not necessarily a piece of construction complete in itself,—it would fall to pieces without abutments. *Bridge.* Thus, a bridge consisting of a series of arches, however extensive, may be but one piece of construction, no arch being complete in itself without the collateral arches in the series to serve as its abutments, and the whole series being dependent thereby upon the ultimate abutments of the bridge, without which the structure would not stand. This illustration is not intended to apply to the widely distended masses of the older bridges, by which each pier becomes sufficient to abut the arches springing from it, but which tend, in providing for a way over a river, to choke up the way by the river itself, or compel the river to throw it down, or otherwise destroy its own banks. A bridge, of which the way is formed upon arches of masonry, may be thus but one piece of construction; and in like manner, *Pointed church or cathedral.* that paragon of constructive skill, the complete church, whether cathedral or otherwise, as built in the Pointed style when that style was practised in full accordance with true constructive principles, is but one piece of construction. As in the long series of arches in a bridge, viaduct, or other such work, in which the piers are vertical supports to the bridging structure, and may be of no greater substance than is necessary to bear the weight coming directly by vertical pressure from the superincumbent structure and its possible load, but throwing all the pressure arising from weight acting laterally, or as thrust, upon terminal abutments,—nothing may be omitted, as nothing can be removed from the structure of the Pointed arch cathedral, or other church built in that style, the whole system of which is bridge-like in construction, without leaving something unsupported or unresisted that requires vertical support or lateral resistance. The western towers of a Pointed cathedral form effective abutments to the long series of arches of the inner ranges over the piers which stand between the nave and the aisles on both sides, whilst turrets or massive buttresses and deep porches upon the northern and southern transept fronts perform the same services in respect of the arches of the transepts. The counteracting east end of the chancel forms a true constructive abutment to the arches of the chancel, whilst the tower, with, it may be, a spire upon it, at the intersection of the four grand compartments of the cross, gives, by its weight, abuttal to them all. The want of this last-named grand and essential body in the system is but too strongly marked in many of the English cathedrals, by the iron bars which have been applied to tie in the arches of the nave;

transepts, and chancel, and to relieve the piers upon which the transept arches bear at a higher level from the thrust to which, being without the weight of a tower upon them, they have continually yielded. Transversely the weight and the thrust of the vaulted ceilings of the nave are brought up to, and thrown against, the piers of the clerestory, which stand upon the main piers or columns of the interior below, and are abutted by flying buttresses, which carry the thrust down to the pinnacle-weighted buttresses of the outer aisle walls, which have already received the weight and thrust of the vaulted ceilings of the aisles themselves. Corbels in the walls and spreading capitals upon shafts take the weight directly, and leave the walls and piers but little encumbered in the middle, so that the vertical structure is continued upwards without bearing upon the springing stones of the arches.

But it is not necessary that the arch employed should be the Pointed arch, to produce combinations as effective in construction as the most perfectly designed and extensively elaborated work of the kind referred to as models of constructive skill; the skill consists in a full and clear perception of the bearing and leaning of every part, and of the means necessary to support and counteract the bearings and the leanings within the reasonable limits of the work with reference to its object and purpose—to the end that the work may become complete in itself, and independent as a piece of construction of everything beyond it.

ills.

In making reference to the noble works of construction above referred to, in which the art of the mason is mainly employed, as works exhibiting construction most fully and most truly, the hall must not be passed over without remark, and of all the great halls of the class to which Westminster Hall belongs, it is itself the most effective as a work of construction; and its effect is wholly produced by the magnificent roof which covers it. This roof is a piece of carpentry admirably designed to resolve it into a compact body to act upon the walls in the direction of gravity alone. But the designer may not have felt quite certain of the results, so whilst erecting massive walls on which to place his elaborate combination of timber, he threw up against the lateral walls a series of flying buttresses to check any tendency of the roof to spread under its own weight in the absence of a thorough transverse tie; for these buttresses are said to be independent of the walls, not being built into them.

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An application of the principles of construction exhibited in the most perfect works of constructive skill ever executed, as above indicated, may be made in the rougher operations of mere practical utility. The sides of cuttings through certain earths in the formation of lines of inland communication, whether carriage roads, railways, or canals, are sometimes required to be widened out to an inordinate extent because of the looseness or slipperiness of the soil, or must otherwise be retained or held upright by special constructions. The expense of the first formation of a cutting under given circumstances is easily calculable, and so is the time within which the work may be effected. Experience has proved that there is for every soil a limit in depth beyond which it becomes more expedient to drift the required way, and construct a vaulted tunnel of sufficient dimensions, than to make an open cutting with the requisite slopes. Even when the first cost would not decide the question, the preference is nevertheless often given to the tunnel because of the greater security of constructed work.

attings.

Retaining
valls.

Before proceeding to the consideration of the means of enabling opposite retaining walls to assist each other, it may be worth while to consider, whether retaining walls are generally constructed so as best to adapt their components to the duty to be performed. No one would place a buttress intended to resist the thrust of an arch within

Buttress.

the springing walls, or under the arch whose thrust is to be resisted; yet in the construction of retaining walls, according to the common practice, the counterfort is placed on that side which receives the pressure, where its utility is very questionable, except to keep the retaining wall from falling back against its load, which, from the transverse section generally given to such walls, they would be apt to do, if not so propped up by their counterforts. Wharf and quay walls, and the revetment walls of military works, may require a face unbroken by projections; but this is not the case with retaining walls for roads and railways, where a long line of projecting buttresses would be unobjectionable, the counterforts becoming buttresses and merely changing places with the wall. On account of the common practice of battering the faces of retaining walls in curved lines, and of radiating the beds of the brickwork composing them from the centre of curvature in every part, the back of the wall must contain more setting material than the face, with the same quantity of solid brick, that is, if the work be bonded through. Counterforts must be built in the same courses, and consequently must have still thicker beds of compressible mortar than the wall; or the bond between the wall and its counterfort must be dropped, and the counterfort thus become utterly inefficient.

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The retaining walls in the cutting upon the line of the extension of the London and North-Western Railway, from Camden Town to Euston Square, are, according to the common practice, built wholly of brickwork in radiating courses and with counterforts following their own contour. In this case the centre of gravity of the wall falls wholly

Exam-
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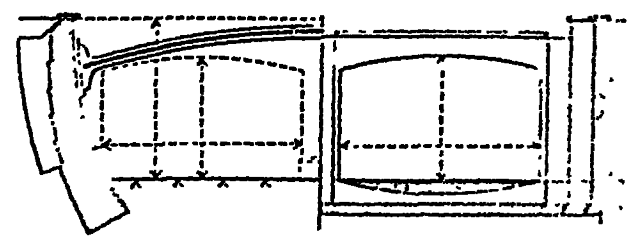


Fig. 1.

Transverse section of the Euston Incline retaining walls, one-half as executed with cast-iron struts to counterforted and relieving walls, and the other half with the brick-built abutting beam to counter-arched retaining walls strutted at the toes of the springing walls by inverted arches

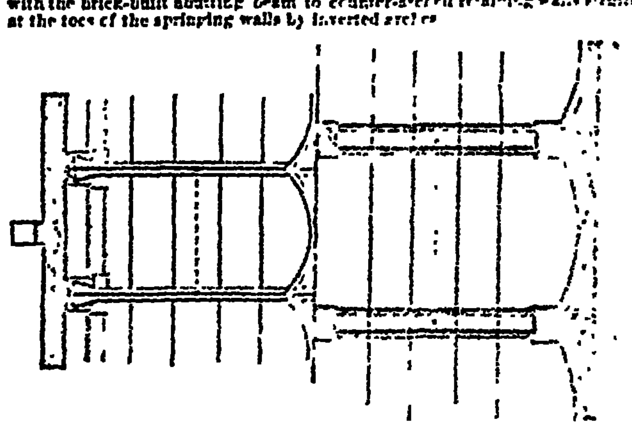


fig. 1, to make each aid the other, was applied to meet the emergency; but this is limited to the upper parts of the walls.

Abutting struts from opposite walls, occurring at intervals only, leave the intermediate portions of the walls exposed to pressure from behind without support, unless these intermediate portions are so disposed as to communicate the pressure upon them to the struts. Hence a common retaining wall, abutted at intervals, would require these intervals to be more or less distant, in proportion to the strength of the wall between them. Instead, therefore, of a continuous wall on each side of the cutting, buttress walls should be placed at intervals, opposite to one another, and strutted apart at their toes by an inverted arch (as in fig. 2); and above, at a height sufficient for whatever traffic the cutting is to accommodate, by a built beam of brickwork, in vertical courses, supported on an arch, and prevented from rising under the pressure by an invert upon it, as in fig. 3. This built beam will then be, as it were, a piece of walling turned down on its vertical transverse section, and will resist any pressure brought upon it through the buttress walls, to the full extent of the power of such a wall built vertically to bear weight laid upon its summit; the pressure would be applied in the line of the greatest power of resistance, and there would be no tendency to yield, except to a crushing force. Let such transverse buttress walls, so strutted apart, with the road between them, be the springing walls of longitudinal counter-arched retaining walls, which, being built vertically and in horizontal courses, but arched in plan, against the ground to be retained, will carry all the force exerted against them to their springing walls, and the springing walls or buttresses will communicate, through the struts, the power of resistance of each side to the other, and thus insure the security of both.

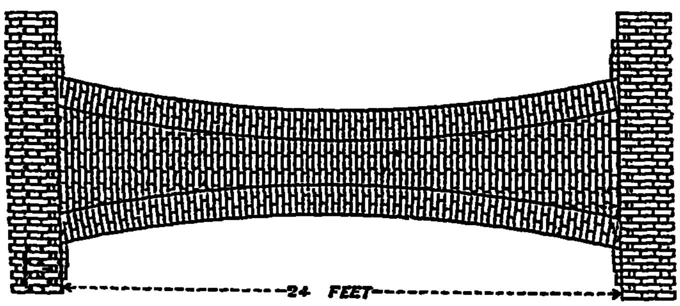


FIG. 3.—Built abutting Beams.

This arrangement may be carried to any extent in height, by repeating the abutting beam or strut at such intervals as the thrust to be resisted and the strength of the buttress springing-walls may require.

ty of als. To constructions thus arranged, any requisite power may be given, by altering the quantity of materials in each part,—the length of the buttresses transversely of the cutting, the number of struts to each pair of buttresses, or the length of the compartments. The thickness of the buttresses should be in proportion to their height and length, and their length should be in proportion to the flatness and weight of the struts with their arches, and to the space in height between any two of them, as well as to the magnitude of the thrust brought to them by the counter-arched retaining walls. The inverted arch below and the built beam above must, of course, have sufficient substance to enable them to resist, without yielding in any direction, the pressure brought to them through the buttresses; and the retaining walls themselves must have substance given to them according to their height, to the pressure they are liable to receive from behind, to the length of the compartments, and to the extent of their flexure;—subject, of course, as to all these, to the nature of the materials, workmanship, and mode of structure.

The positive strength which such constructions should possess depends much, of course, upon the nature of the soil, and its susceptibility of being affected by external influences; but it depends, even in a greater degree, upon the manner in which the constructions can be applied to the ground they are intended to retain. A very slight power will retain at rest a body which the exertion of great force could not stop if once in motion, and a half-brick counter-arch, set in close contact with undisturbed ground, would hold safely up what three times the substance would not stop if there were space and opportunity for motion between the ground and the brickwork. It is impossible, therefore, to state precisely what is the least strength which the retaining constructions must have, but there can be no question that too much strength is better than too little, and it is generally cheaper to pay in materials than in labour to save materials. Strength of the constructions.

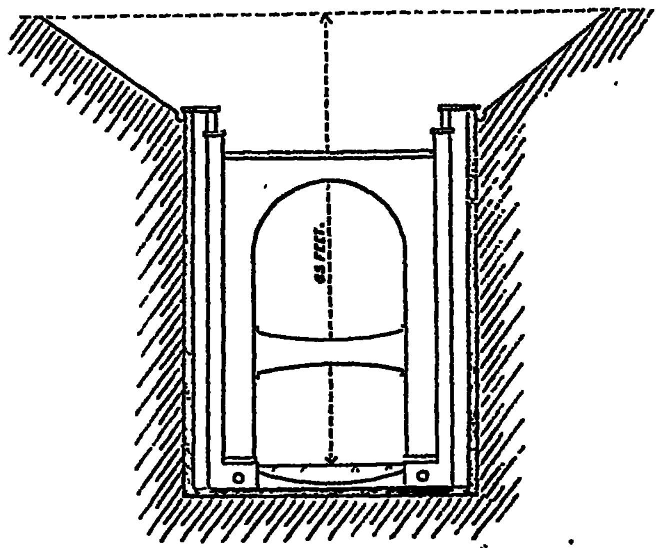


FIG. 4.—Transverse section through the centre of a Bay.

The diagrams, figs. 4 and 5, represent a cutting 65 feet deep to the level of the rails. It is assumed that the ground at the top may stand for the first 15 feet at less than 2 to 1, and that it may, therefore, be cheaper to run out to that depth with slopes, leaving 50 feet from the rails, or about 52 feet in all, to be retained. As the bricklayer may follow up the excavator with bay after bay, his work lying mostly on the side and out of the way of the excavator, the latter would run out the spoil without interruption, his work being benched onwards and shored as he proceeded. As every compartment, with its buttresses, invert, abutting beams, and counter-arches is complete in itself, the ground being backed against the counter-arches as the work rises, the shoring would come out, and be sent on for use on the forward benches. The invert may be turned upon footings in half-brick rings, to get the largest quantity of solid resisting matter in the curved line. At a height from the surface of the rails sufficient for headway—assumed at 14 feet 6 inches—a 14-inch bonded arch is turned from buttress to buttress, springing from skewbacks on corbelled courses. Upon the back of this arch the abutting beam is built of brick on end and edge, bonded as a wall, with beds vertical and widening over the haunches of the discharging arch and under the similar inverted arch turned upon it; so that although the beam be in the centre but 21 inches deep, it presents an abutment at each end of three times that depth. The object of the invert over the abutting beam is to stiffen it, and to bring down and distribute the weight and pressure from the buttresses more effectually. The built beam, and its sustaining and stiffening arches, An example of a cutting.

should be composed of particularly well-formed bricks of really good quality, set in cement or in some quick-setting mortar, that there may be no yielding to the pressure which must be immediately thrown upon this part of the construction. Another built beam, of greater depth, because of the absence of any inverted arch to stiffen it, is thrown across over the back of a semicircular arch, with its abutting ends extended in like manner.

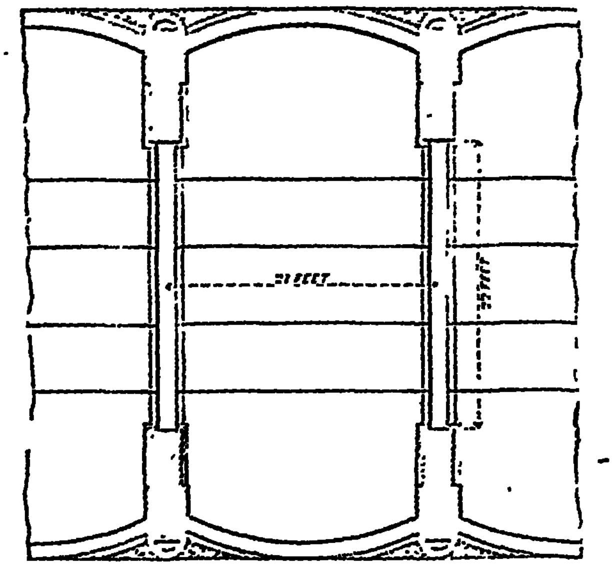


FIG. 5.—Plan at twice the scale of the Section (fig. 4).

Drains. To relieve the work from water, a drain being run along over the middle of the inverts, or side-drains being passed by ring culverts through the buttresses, drain-shafts are carried up at the backs of the buttresses against the springings of the counter-arches, to within a few feet of the surface. These shafts, being steened with open joints at intervals to admit drainage water and communicating with the drains below, prevent the possibility of water lodging about the backs of the counter-arches, or even in the ground itself. The drain shafts should be semi-domed with bricks set dry and covered in, and the walls also backed up with good clean gravel, through which the surface water may percolate and pass freely down to the shafts.

The constructions are assumed to be of brickwork, for the obvious reason that the cases supposed being clay cuttings, brick is the material which would be most economical. But if masonry be cheaper, it may of course be used with the same effect. Where a cutting intersects loose beds of laminated stone, and particularly strata inclined to the horizon, so as to be unsafe with the ordinary slopes, such constructions are available; and in cases where the sides of the cutting will stand vertically or nearly so, as in chalk, it may be useful to apply similar constructions, though of slighter character, to check the separation and fall of masses from the precipitous sides. It is obvious, too, that these constructions present the means of security, when the stratum forming the base of any cutting is too weak to bear the weights of slopes, or of retained sides, without rising between them. Sheet-piling may be driven to any depth along the backs of the counter-arched walls so as to be retained at the head by the walls: and thus in effect the walls would be carried down to a safe depth, even through the weak stratum; whereas such piling at the toes of slopes is commonly found to be almost if not wholly useless, for the want of a stay to the head.

Construction of civic structures generally. The ignitibility of timber, and the rapidity with which it burns when placed in circumstances so favourable to that effect as by its disposition in an erected building, have led to its prohibition for the purposes of the main enclosures of houses and buildings generally, in London, and in many of the larger provincial towns. It is possible, however, so to protect timber employed in the enclosures and for the internal partitions and floors of buildings as to render mere dwelling-houses practically incombustible. Whilst, however, the liability of timber to take fire and to burn may in a great measure be counteracted, and notwithstanding that this material combines the advantage of economy with security, stone and brick are undoubtedly better adapted for the main structure of a building. Brick or stone, or brick and stone together, with a setting material, ought to be employed, but in such manner only as to be free from dependence upon other and less trustworthy materials. The most perfect erections as buildings are those in the composition of which this principle has been understood and fairly practised. If adventitious aid be given to brick or stone walls by foreign materials, the materials ought to be at the least harmless. Iron in bulk is not a proper Iron substance to incorporate with walls because of its great expansibility by heat; but iron used in thin laminæ, as hoop-iron laid in walls in the bed-joints of the brick or Hoo stone, cannot be productive of any bad consequences, while it is most beneficial in that form as a tie to the structure.

Bricks come ready shaped to the hands of the workman Brick in a form the best adapted for the arrangement in the con- struc struction of a wall which, under the designation of bond, gives it such a degree of consistency that a weight placed upon the top is carried by the wall in every part throughout its whole thickness, and throughout a greater or less proportion of the length according to the height of the wall. Stone, on the other hand, comes to the workman without regular form; and with skill on his part to dispose and arrange the materials, good erections may be produced of rubble; for although the thickness of which walls may be built of rubble with safety will depend in a great degree upon the quality of the mortar, much depends also on the skill of the workman in bedding and bonding the stones. Under any circumstances, however, a wall so composed cannot safely be charged with heavy weights, or be exposed to the vibrating action of floors, until the mortar shall have indurated to some extent; whereas a wall of brickwork is secure by the horizontal bedding of the bricks, and by the effect of the transverse bond which the alternation of header and stretcher almost necessarily produces

the height of the structure; but they ought not to be determined by that condition alone. Chimney-breasts, or other buttress-like projections, built up with a wall, and extending to more than the thickness of the wall, make it in fact stronger in its transverse section, and justify less general thickness in the body of the wall, whilst window and other openings in a wall leave piers which ought to be of greater thickness than the mere height would require. But all returns, indeed, whether as chimney-breasts or as cross walls, built and bonded with a wall, tend to render unnecessary the full thickness which the height might require; whilst, as just intimated, the omission of portions of a wall for door and window openings should be compensated for by additional substance to the parts which remain. Walls subjected to undue action, such as that arising from slight joists tailed into them, or that occasioned by inclined timbers, as under galleries in churches, chapels, and theatres, require to be of greater thickness than they otherwise would; whilst it is quite wonderful to what great heights brick walls may be built with safety, if they are well built, and exposed to no other action than direct vertical weight. When, indeed, such walls stand upon a sufficient foundation, direct vertical weight without motion is a means of security to the walls so long as the weight is reasonably within the power of resistance of the materials to crushing pressure. The object to be looked at, therefore—the walls being honestly built—is, as before remarked, to make the weight to be imposed upon any wall act upon its solids vertically and steadily.

Floors upon girders, or framed to strong trimmers—the girders or the trimmer-joists running into and bearing upon the piers or solids of the walls—are far preferable to what are termed single floors, of which each joist runs into the wall. Girders as the basis of floors render plates in the walls wholly unnecessary, by depositing the weight in the right places, without requiring plates to carry it on from the weaker to the stronger places; and being of necessity stout and rigid, they form a fair tie and strut to the walls into which their bearing ends are tailed. Whether girders or trimmer-joists be employed for placing the weight of floors upon the walls of a building in the safest manner, the bearing timbers ought to be placed upon pieces of stone as templets built into the walls, and to be made to take a cog-hold of the templets, so as to enable them to tie and stay the walls by means of the cogs. It is by means of the girder bearing upon the solids of the walls, though with bad carpentry, that the French are able to carry up their soft, coursed-rubble, stone walls to heights that would certainly be unsafe if the walls were seamed with wooden plates, and shaken by floors of single joist; such, for instance, as a wall of a total height of say 85 feet, with a thickness of 18 English inches on the ground-floor and through six stories, or about 65 feet, and finished by a gable,—the basement being vaulted with walls about 20 inches thick. It is by means of the solidity given to the floors by the girders, and the solid bearings which the girders obtain, that the floors are able to carry the dead weight of matter which renders them practically fireproof, as described below, in addition to the moving weights to which the floors of buildings are necessarily exposed in use. We can and do frame floors most effectively by carpentry alone; whereas the French do the work so badly, that no important bearing is, or indeed may be, trusted by them to the framed joint—dog-nailed stirrup straps of iron being always brought in aid. But the common practice in England is to use single or unframed floors, which carry the weight and the vibration to which floors are exposed into the walls, over voids as well as over solids; while the French frame their floors to or upon girders, by means of which the floors are brought to bear upon the solids of the walls. The walls are thus not only less exposed to vibratory action, but are both tied together and strutted apart with better effect by the stout girders stiffened by joists than by joists which themselves require some foreign aid to stiffen them. Moreover, single floors of joists, unless trimmed at frequent intervals, when, indeed, they may be termed half-framed, are supposed to require plates of timber laid along the inside faces of outer walls and upon internal walls. This defect is avoided by French builders, who exclude all timber, except the bearing ends of girders, from their walls, and use framed floors.

Wall-plate and roof. When the walls of a building have reached their full height, the wall-plate comes into use legitimately—to cope the walls, in fact, and to form a curb as a base upon which to place the roof, which should deposit its weight, nevertheless, by means of its tie-beams upon the plates over the solids of the wall below, and which should, moreover, oversail, so as to cover and effectually shelter from the weather the enclosing walls also.

Cast-iron girders. In setting forth the structural advantages derivable from the use of girders as the bases of floors, it may be necessary to repeat the warning already intimated against the use of girders of a material of uncertain strength, and of treacherous character when exposed to transverse strain. Cast-iron is of uncertain strength, mainly because of the imperfections which the most skilful founders, with the best materials and every appliance at command, cannot always avoid, and which are most liable to occur in the production of complex forms in long lengths; whilst careless founding and rapid cooling are contingencies connected with the production of cast-iron girders—which are necessarily long and complex castings. Cast-iron is treacherous, inasmuch as it is brittle and liable to be startled into fracture by impact trifling when compared with what it may have borne safely as a dead-weight. Proving long metal castings by straining them upon their transverse section does but aggravate imperfections, and leave the casting weaker; whilst no dead-weight proof is proof against blows or other action inducing vibration. It is only under circumstances which do not admit of concussive action upon the beam, or which prevent it from vibrating under any shock that may reach it, that cast-iron can be safely used in beams of long lengths to carry heavy weights, without some appliance to mitigate, at least, the imperfections which this substance exhibits. The application of wrought iron tension bars as soles to beams and girders of cast-iron **Tension bars.** would prevent the most serious consequences from attending the failure of the casting, if the beam were also prevented by binders, or by other sufficient means, from turning round when the blow produces an oblique fracture. Wrought iron girders can be and are now extensively used to carry floors, partitions, and even walls with safety.

Foundations. Inasmuch as some soils are liable to change in form, expanding and contracting under meteorological influences, as clays which swell when wetted and shrink when dried, concrete foundations are commonly interposed upon such soils to protect the building from derangement from this cause; or rather, for that purpose walls of the cheaper material, concrete, instead of the more expensive brick or stone structure, are brought up from a level sufficiently below the ordinary surface of the ground. When concrete is used to obviate the tendency of the soil to yield to pressure, expanse or extent of base is required; and the concrete, being widely spread, should therefore be deep or thick as a layer, only with reference to its own power of transmitting to the ground the weight of the wall to be built upon it, without breaking across or being crushed. But when concrete is used as a substitute for a wall, in carrying a wall down to a low level, it is in fact a wall, wide only in proportion to its comparative weakness in the

absence of manipulated bond in its construction, and encased by the soil within which it is placed.

The foundation of a building of ordinary weight is, for the most part, sufficiently provided for by applying what are technically termed footings to the walls. The reason for a footing is, that the wall obtains thereby a bearing upon a breadth of ground so much greater than its own width or thickness above the footing, as to compensate for the difference between the power of resisting pressure of the wall and of the ground or ultimate foundation upon which the wall is to rest. It will be clear from this, that if a building is to be erected upon rock as hard as the main constituent of the walls, no expanded footings will be necessary; if upon chalk, upon strong or upon weak gravel, upon sand, or upon clay, the footing must be expanded with reference to the power of resistance of the stratum to be used as a foundation; whilst in or upon made ground, or other loose and badly combined or imperfectly resisting soil, a solid platform bearing evenly over the ground, and wide enough not to sink into it, becomes necessary under the constructed footing. For this purpose the easiest, the most familiar, and, for most purposes, the most effectual and durable, is a layer of concrete, which may be formed so as to cover a surface large enough to obtain from the most yielding soil the amount of resistance to pressure required to support the weight of the intended building. It will be evident that upon a concrete foundation a footing or expanded base may or may not be required to a wall, according to the hardness of the concrete and the kind of wall to be built; but it is perhaps better to give the footing to the wall than to wait for the sufficient induration of the concrete to enable the wall to do without a footing; and better still, to lay the concrete of such height only with reference to the spread or extent of base beyond the toes of the footing, as the gravel of which the concrete is made would stand at in an uncombined condition. Concrete, indeed, is at all times more safely to be regarded as a substance to be placed as a layer, than as a substance to be set up as a wall; for although excellent erections as walls may be made of concrete—as erections in the same form may be made of tempered clay or of pisé-work—neither concrete nor tempered clay is to be regarded as a proper substance with which to form the lofty walls of buildings in towns. The use of lime concrete involves walls of a considerable thickness; Portland cement concrete, a stronger material and having the property of hardening rapidly, is more commonly used for thin walls. Several patents have been taken for erecting buildings with concrete walls by the construction of troughs formed of frames and movable boards or shutters. But considerable doubt exists as to the extent to which such walls can be built, as many have cracked, proved leaky, and shown other faults; whilst much economy does not result except where the work is very plain and straightforward, where little is spent on subsequent finish, and where the materials can be obtained at very little cost either for themselves or for carriage.

Construction for Protection against Fire.—Houses seldom take fire from common accidents, such as occur to the lighter movable furniture and to drapery; but, for the most part, from the exposure of timber in or about the structure to the continued action of fire, or of heat capable sooner or later of inducing the combustion of timber; and as the source is most commonly in defective gas-piping, or in some stove, furnace, flue, pipe, or tube, for generating or for conveying heat, or for removing the products of combustion, much of the real danger to buildings from fire would be prevented by avoiding that degree of proximity of timber to all such things as can lead to its combustion. With a view to lessen the danger to which buildings with timber in their structure are exposed from fire, it will be well to consider how far the timber and wooden fittings commonly used may be necessary either to the stability of the buildings, or to the comfort and convenience of the inhabitants. But it is not our intention to describe here the various modes of fire-proof construction, but only to notice the principles upon which ordinary buildings may be rendered nearly *incombustible*. So long as danger of fire is brought to buildings through pipes and tubes, the necessity must be admitted of guarding the combustible materials used in buildings from any chance of becoming ignited. When heat is produced and passed through pipes in any manufactory, whether it be to act as power, or for drying or for warming, the fires used may be guarded, and the machinery which regulates the intensity of the heat to be transmitted may be under constant care; but even in such cases there can be no certainty that the heat shall not at some time arrive at the point of danger. But when heat is diffused throughout dwelling-houses by means of apparatus which is committed to persons unskilled in its use, and unconscious or careless of the danger which may arise from neglect, it seems impossible to lay down inflexible rules for distances from timber which shall render it safe from heated pipes. Twelve or fifteen inches may not be a greater distance than safety requires under some circumstances, whilst there are many cases in which the actual contact of such pipes with timber is hardly inconsistent with safety. When the air about heated bodies is not confined, as it would be within the timbers of an ordinary floor, a distance between the timber and the heated surface equal to the longest diameter of the tube or pipe will be found sufficient if the temperature of the pipe does not exceed that of boiling water. It is to be understood that a piece of wood will bear a powerful dead-heat upon its sides for an indefinite period without igniting, unless a transverse section of the fibre, as at or around a live knot, or where a branch had been lopped, present itself to the action. It is by the end that a piece of wood exposed to powerful heat most readily ignites. The gases evolved in the substance of the timber by the action of heat applied to its surface, expanding as they are evolved, are thrown out by the pores among the fibres at the ends, if the ends are near enough to the action to allow of this effect, with less power than may be enough to obtain vent for the inflammable gases laterally.

or 40 feet; and walls of such lengths and heights could hardly be deemed safe if not more than one brick thick. Consequently, a greater thickness has been prescribed as the least thickness of the walls of buildings of the sizes indicated. In the older Metropolitan Building Acts much greater thicknesses were prescribed for the walls likely to be the longer walls; whilst the only necessity for more than one brick rises from structural requisites, and not from any insufficiency of a wall of solid brickwork one brick thick as a means of preventing the spread of fire.

rtitions.

But the requisites of the structure would be as well fulfilled by one-brick walls upon the long sides as by 1½ brick walls, if the ordinary internal cross partition for dividing a house into front and back rooms were built of brickwork abutting upon, and at right angles to, the longer walls, and carried up coursed and bonded with them. That is to say, party-walls of one brick or 9 inches in thickness, connected at their ends by 1½-brick or 13-inch front and back walls, and at or about the middle of their length by other 9-inch cross walls, would be at the least as strong as 1½-brick party-walls, though connected in the same manner at the two ends, but without the abutting and connecting cross wall of brickwork. Instead, however, of such internal cross walls, hollow partitions of timber are commonly used in all stories above the basement story; and it is by these partitions, and by the light and highly inflammable wooden stairs, that fire extends itself rapidly throughout ordinary dwelling-houses; whilst the substitution of a brick wall for the cross timber partition would in most cases justify the abatement of a half brick of the thickness otherwise necessary to party-walls, and give an indestructible internal support to the floors, whereby also one of the means by which fire travels rapidly through a house would be removed. It is true that there must be openings as doorways, and fittings in them for doors, in such internal partition wall; but the wall could not carry fire up from floor to floor through its own heart, as the hollow wood-lathed quartering partition carries it. Doors and shutters, and door window linings, in and against brick or stone walls, may take fire and burn in any story of an ordinarily built dwelling-house, without carrying it beyond the story in which the fire occurs; for a plastered ceiling of the most common description will resist the action of flame upon its surface for a long time, and plastering of really good quality, though upon wood laths, will keep fire off from the joists by which it is held up, almost without danger, so long as the fire acts upon the face only of the plastering. If, however, fire reach the joists through the agency of hollow quartering partitions, the enemy has turned the flank of the plastering, and the floors and skirtings above and behind it taking fire, the building almost inevitably falls a prey to the flames. Any step, indeed, from the hollow quartering partition towards a solid wall is a step towards security. A brick wall is, perhaps, the best internal partition for all the purposes of strength and security from fire; and in small houses, which will not afford the expense of 9-inch walls, half-brick walls with 9-inch jambs at the doors, and short 9-inch piers on alternate sides of the partition, at intervals of 3 or 4 feet in length, will give sufficient strength; but even quartering partitions, if based upon brick walls, may be rendered nearly proof against fire by brick-nogging them, especially if care be taken to fill in with brickwork between the joists over the head of one partition and under the sill of another, as well as between the timbers of the partitions. Filling in between the joists, and up as high as the skirtings go, will do something, indeed, towards diminishing the dangerous tendency of even lathed and plastered timber partitions; whilst the adoption of the plan now commonly practised in Paris, in forming not only internal partitions, but the rearward external enclosures of buildings, would secure to the structure the structural efficiency of timber on end in carrying weight, and give the solid and incombustible character of a brick or stone wall to a partition or enclosure which is structurally of timber. The plan referred to is, to frame and brace with timber quarterings much in the manner practised in England, except that the timber used in Paris is commonly oak, and is generally seasoned previously. The framed structure being complete, strong oak batten-laths, from 2 to 3 inches wide, are nailed up to the quarterings horizontally, at 4, 6, or even 8 inches apart, according to the character of the work, throughout the whole height of the enclosure or partition; and the spaces between the quarterings, and behind the laths, are loosely built up with rough stone rubble, which the laths prevent from falling out until the next process has been effected. This is, to apply a strong mortar, which in Paris is mainly composed of plaster of Paris, which is there of excellent quality, laid on from both sides at the same time, and pressed through from the opposite sides so that the mortar meets and incorporates, embedding the stone rubble by filling up every interstice, and with so much body on the surfaces as to cover up and embed also the timber and the laths—in such a manner, indeed, as to render the concretion of stone and plaster, when thoroughly set, an independent body, and giving strength to rather than receiving support from the timber.

Partitions as formed in England

The English brick-nogged partition is, in point of structure, nothing without the aid of timber. The plastering is merely spread upon the surfaces of brick and wood, and is fragile in the extreme, and always liable to crack and drop off. This lathed and plastered partition is composed of the hollow framework of the timber quarters, with two slight thicknesses of mortar, as plastering, hung upon slighter laths, over and between which the flaccid mortar forms a key for itself; but all necessarily depends upon the timber, and fails with it wherever decay or fire may destroy it.

Stairs.

Only second in importance to the internal partition as a source of danger, or as a means of safety, are the stairs; and the stairs are second in importance only when the partitions are made to carry the floors of the several stories. In England, and in London particularly, even when the steps and intermediate landings are of stone, it is but too common to find the passage from the street door to the foot of the stairs, and the floors which connect flight with flight at the several landings, either wholly of wood or of slight stone paving laid upon wooden joists or bearers. Any stone paving upon wooden joists will certainly retard the action of fire upon the joists, especially if assisted by a well-plastered ceiling; but in this, again, if the floors be not formed of wholly incombustible materials, the French practice as to floors would be better than ours.

In Paris stone stairs are far less common in modern houses than they are in London in houses of corresponding character and date; but wooden staircases in Paris are rendered almost as safe as common stone staircases are in England, by a process similar in character to that applied to partitions and enclosures. The result is an almost incombustible structure. Wooden staircases formed between brick or stone walls, or between partitions of the kind above described as commonly made in modern buildings in Paris (that is, filled with a solid mass of concreted rubble), may perhaps be set on fire, but they can hardly burn.

Ceilings and floors.

It has been remarked that a mere plastered ceiling will resist the action of fire for a long time, although the plastering be upon wooden laths, and the laths nailed to joists of timber; and as fire does not readily act downwards, flooring boards may take fire from above without any immediately serious consequence to the joists under them,

so long as there is no access of air from below. But the English indoor plastering upon laths is commonly of the most fragile kind, and the slightest weight falling upon the back of a ceiling will make a breach through it, whilst the floors are commonly of deal laid upon fir joists, and are exposed to the action of fire from below directly the lathed and plastered ceiling has failed; if, indeed, the fire have not found its way to the joists under the flooring boards by the hollow lathed and plastered quartering partitions. In the timber enclosures and partitions, which economy induces the Paris builder to introduce as substitutes for walls, the timber is so embedded in and made part of a solid concrete, as to be protected from almost every casualty of which it is susceptible. But the French render their floors also so nearly incombustible as to leave but little to desire in that respect, and in a manner attainable with single joists, as well, at the least, as with joists framed into girders. According to their practice, the ceiling *must* be formed before the upper surface or floor is laid, as the ceiling is formed from above instead of from below. The carpenters' work being complete, strong batten-laths are nailed up to the under sides of the joists, as laths are in England; but they are much thicker and wider than our laths, and are placed so far apart that not more, perhaps, than one-half of the space is occupied by the laths. The laths being affixed—and they must be soundly nailed, as they have a heavy weight to carry—a platform, made of rough boards, is strutted up from below parallel to the plane formed by the laths, and at about an inch below them. Mortar is then laid in from above over the platform and between and over the laths, to a thickness of from $2\frac{1}{2}$ inches to 3 inches, and is forced in under the laths, and under the joists and girders. The mortar, being gauged, as plasterers term it, or rather, in great part composed of plaster of Paris, soon sets sufficiently to allow the platform to be removed onwards to another compartment, until the whole ceiling is formed. The plaster ceiling thus produced is, in fact, a strong slab or table, in the body of which the batten-laths which hold it up are incorporated, and in the back of which the joists, from which the mass is suspended, are embedded. The finishing coat of plastering is then laid on. Such a ceiling will resist any fire that can act upon it from below, under ordinary circumstances; and it would be difficult for fire to take such a hold from above as to destroy the joists to which a ceiling so composed is attached, the laths and the under side of the joists being alike out of its reach; and consequently such a ceiling alone would diminish the danger from fire, although the floor above the joists were laid with deal boards.

oring terials. A boarded floor, however, in Paris is a luxury not to be found in the dwellings of the labouring classes, nor, indeed, are boarded floors to be found in any dwelling-houses but those of the more costly description. Whether the proposed surface is to be boarded or not, however, the flooring joists are covered by a table of plaster above, as completely as they are covered by a plaster ceiling below. Rough battens, generally split and in short lengths stout enough to bear the weight of a man without bending, are laid with ends abutting upon every joist, and as close together as they will lie without having been shot or planed on their edges. Upon this rough loose floor, mortar of nearly similar consistence to that used for the ceilings is spread to a thickness of about three inches; and as it is made to fill in the voids at the ends and sides of the floor-laths upon the joists, the laths become bedded upon the joists, whilst they are to some extent also incorporated with the plaster. The result is a firm floor, upon which, in ordinary buildings, paving-tiles are laid, bedded in a tenacious cement. It must be clear that the timbers of a floor so encased could hardly be made to burn even if fire were let in between the floor and ceiling. But it has been already stated that the practice of making these incombustible floors is connected with the use of walls which have no timber laid in them bedwise, and that the timber enclosures employed instead of walls, and the internal partitions, are rendered practically incombustible, whilst the wooden staircase which economy dictates to the Parisian builders—the freestone which is used in building walls being altogether too soft for the purpose—is also rendered, in the manner already shown, almost unassailable by fire.

It may be remarked with reference to the employment of any substance such as cinder, being of the nature of pozzuolana, or volcanic scoria, in mortar, to form a floor in the manner above described (about 3 inches thick), that as all such mortars expand in setting, the walls of buildings may be forced out by the expansion of the plaster floors, if the whole surface of the floor in any story be at once covered with the mortar. A margin of 4 or 5 inches on every side should be left void until the expansion has taken place, when the floor may be completed with an assurance of close joints, and without injury to reasonably stable walls. E... of floors.

When a boarded floor is required, as the surfaces of the true joists lie under the mortar, a base for the boards is formed of what English carpenters would call stout fillets of wood, about $2\frac{1}{2}$ inches square, ranged as joists, and strutted apart to keep them in their places, over the mortar table, to which they are sometimes scribed down, and that to these fillets, or false joists, the flooring boards are secured by nails; so that in truth the boarded floor is not at all connected with the structure of the floor, but is formed upon its upper coat of plaster. The wooden floor thus becomes a mere fitting in an apartment, and not extending beyond the room the floor might burn without communicating fire to the stairs, even if the stairs were readily ignitible.

The practice now in Paris, in respect of floors, is to form the structure of wrought iron joists rolled to the form known with us as I, T, and I iron, and to fill in with the same strong plaster between, below, and above the iron, and so to form a slab of plaster from 6 to 8 inches thick, according to the bearing and the depth of the iron bars—the bars being enveloped in the plaster; and the ceiling is formed as before described by laths resting on the lower flanges. In order to lighten the weight of the solid plaster, earthen pots have been placed between the joists and the spaces filled up with the mortar. Floors iron

The necessity which arises with us of dividing the upper stories of houses into more rooms, as bed-rooms, than are commonly required in the lower stories, will be made an objection to any process that would render the partitions heavier; but it is not in the upper stories that the lathed and plastered partition is most dangerous in respect of fire. Generally the stairs may be enclosed by solid partitions throughout almost the whole height of an ordinary dwelling-house without occasioning any inconvenience as regards the greater weight of such a partition; and generally, too, the partition which divides the front from the back rooms of such houses may be carried up throughout the whole height of a house without removing the bearing, if the house be judiciously disposed. But even if a partition rest upon a beam or girder, a very slight addition to the scantling of the timber will make up for the additional weight which the filling in of the partition would involve, if the materials of the core be well chosen; and it is well known that a piece of timber placed over a void as a bressummer, and carrying a wall, resists the action of fire for a long time, and the longer if it be of oak or other hard wood. It is not necessary, however, that the timber employed in parti- Upper partiti.

tions and enclosures should be of oak; though it is desirable that main bearing timbers, in situations which render them most liable to be exposed to the action of fire in the event of casualty, should be of such timber rather than of fir; but the quarterings, or partition timbers, which the plaster concrete wholly encases, may be of fir as safely almost as of oak.

ring. The core used in Paris consists for the most part of chips and spalls arising in the process of dressing the soft free-stone which is the main constituent of the walls of most buildings in that city. Almost any hard material, however, will furnish rubble fit for the purpose, which must be angular and irregular in form, so as to allow the mortar to pass freely through the rubble, and embed it all. Rubble of brick material, as broken burrs, or even of old bricks freshly broken, will answer very well; but if brickbats or shreds of plain tiles be used, care must be taken in packing not to bring flat beds together, or the mortar will not pass through and make a perfect concrete. Rubble of almost any kind may be used; but the kinds of stone which are themselves concretions, and present rough surfaces upon the fracture, are the best, while schistose or scaling slaty stones are the worst for the purpose. But there is no better substance for coring partitions upon the plan described than clay burnt into a kind of brick rubble.

The same process applied to external enclosures will justify the use of timber in their structure in situations and under circumstances in which it may be properly prohibited when the timber is merely lathed and plastered, or even brick-nogged, for brick-nogging adds nothing, as already remarked, to the strength of a partition or an enclosure, but rather takes from it, being itself a source of infirmity. But chimneys and their flues, with their congeners, stoves and furnaces, ought not, under any circumstances, to be formed in an enclosure in which timber is employed as a part of the structure.

Under some circumstances, again,—that is to say, when any street of a town is so wide and the buildings to be built fronting it are to be of such small elevation, as to make the communication of fire from one side to the opposite side practically impossible, if the buildings adjoining laterally are effectually separated from one another by sufficient walls, party or otherwise, and these project before the outside faces of the front and back enclosures so as effectually to prevent fire from passing round them,—the temperature of dwelling-houses may be much more easily maintained and regulated if the outside surface be boarded. Weather-boarding is a safe and economical, as well as a neat, wholesome, and equable outside casing for the fronts of a dwelling-house, if the boarding be backed up solidly, and the timber quarterings necessary to secure it be properly filled in between and behind with brick or stone work, or with rubble and concrete in the manner already described. Brickwork builds up badly with the raking braces of timber-framed enclosures, and the concrete described would not be so perfect with weather-boarding on one side as if the mortar were thrown in from both sides; but raking braces are less essential to enclosures which are filled in and backed with a heavy body of brick-work or concrete, than when mere lathing or even brick-nogging is to be employed on the inside. A 9-inch brick wall may, indeed, be very well built up with framed quarterings without raking braces, if the work be built between and around the quarterings, carrying, that is to say, the inner half-brick before the inside faces of the quartering, and so as to show on the inside a plain brick wall.

Building Trades.—The artificers whose trades properly belong to the builder's business are the digger or excavator, bricklayer, mason, sawyer, carpenter, joiner, cabinetmaker, slater, plumber, plasterer, modeller, carver, glazier, smith, founder, ironmonger, gasfitter, painter, and decorator. In this order the works of the trades will be described, and we now proceed to the ordinary routine of the practice of building. The two publications which should be noticed here as comprising more detailed references to these trades are Gwilt's *Encyclopædia of Architecture*, 8vo, 1869, edited by Wyatt Papworth; and Cresy's *Encyclopædia of Civil Engineering*, 8vo, 1861,—these will not, therefore, be noticed in the list at the end of each trade.

Foundation.—The architect having furnished the specification and working-drawings of his design, the first step is to prepare the foundation; and as this relates to the bricklayer as well as to the mason, we say what is necessary respecting it here. Much in this particular, it is evident, must depend on localities. It is not of so much importance that the ground be hard, or even rocky, as that it be compact, and of similar consistence throughout; that it be so constituted as to resist entirely and throughout, or yield equally to the superincumbent weight. But in the ordinary processes of building little requires to be said of the artificial preparation of foundations beyond the notice of it already given. When a good, hard soil is easily accessible, as solid gravel, chalk, or rock, we have nothing to do but to remove the surface mould, dig to the sound bottom, and at once to put in the footings. On softer ground it was usual to employ footings at least double the width of the wall, and frequently more; but since the invention, or rather revival, of the use of concrete, this is seldom or never done. In this case, or when the ground is a deep clay, be the material used what it may, it should at least go so deep as not to be affected by change of temperature, or the rising and falling of springs, as the alternate shrinking and swelling of the ground must affect the building. Frost seldom penetrates a foot into the ground in this country; but in clay soils, fissures, the consequences of drought, are found 3 feet and more in depth. The basis should, therefore, be below this point in such a stratum. If the ground be springy, it should be drained, if possible; if not, a foundation should be made with concrete as low as the lowest level of the water; or if very deep or boggy, piles must be used. The plan of building on sleepers and planking, so common some years ago, is very bad, as they rot after a time, and the building settles in all directions, as the greater weights crush the decayed timbers sooner than do the lighter portions of the building. Where ground is alternately wet and dry, the best timber soon decays; even piles should always be kept in the water. The use of concrete, except in very peculiar cases, has entirely superseded every other artificial foundation. It may be defined as a sort of rough masonry, composed of broken pieces of stone or gravel, cemented together with lime prepared in various ways, and thoroughly mixed with it, and not laid by hand but thrown at random into the trenches, to form the depth required.

Foundation. Planking. Concrete.

Any hard substance, broken into small pieces, will make good concrete. That most used is gravel, or ballast. This should not be too fine, as the sand which may be in it will mix with the lime and form a sort of mortar, assisting to cement the stones together. If broken stones or masons' chips are used, it is desirable to add some sharp sand with them. The general rule is, that no piece of stone should exceed a hen's egg in size. In this country the lime is generally ground, which is bad, as the core or unburnt portion is ground up with the good lime. About one-sixth part of lime is generally used; chalk lime should not be used in a damp situation. It is mixed with the ballast by scattering it among the stones, and turning it all over with a shovel, water being at the same time thrown upon the mass. It is then, while hot, filled into the trenches, sometimes by shooting from stages

erected for the purpose 6 or 8 feet above the work; but this process has been very justly censured as uncertain by eminent engineers, who prefer to put it in layers of not more than one foot in thickness, and to level each course, ramming it down thoroughly. When the lime is too hastily put into the trenches, and has not had time to be thoroughly slaked, the process will continue, and the mass will puff or swell and sometimes cause considerable mischief. Wing walls of bridges have been thrust out by this means. To make a solid concrete all the interstices of the gravel should be filled with the sand, and the lime and the water will be absorbed without any increase of bulk. In France the lime is first made into a paste, and the mixture is then called *béton*, not concrete; this is a more scientific process for obtaining a sound substance. In some experiments made by the Architectural Publication Society, where the materials were carefully mixed, no change took place in the bulk; but some experimentalists, practical men, and writers differ on this point, and assert there is a loss of one-seventh in bulk when set. The lime, if it can be procured, should be hydraulic; and concrete is much improved by the addition of the volcanic sands. French authors recommend, as good proportions, one-fifth hydraulic lime, one-fourth pozzuolana, one-eighth sharp sand, and the rest broken stone or gravel; or 20 per cent. hydraulic lime, the same of trass, the same of sharp sand, 15 per cent. of gravel, and 25 per cent. of broken stone. Perhaps the very best concrete is made of a simple mixture of gravel, sand, and Portland cement. It is unnecessary to enter into the details of foundations in water, as this but seldom comes within the ordinary builder's province.

xcavator. *Digger or Excavator.*—The digger works with a pick-axe and a spade or shovel. With the pick-axe he breaks down the soil if it be hard or very stiff, and throws it out with the shovel; but compacted sand and alluvial soil are spitted and thrown out with the spade alone, without previous breaking down. When rock occurs in a foundation, the assistance of the quarryman is requisite to cut through or blast it, as the occasion may require. The digger should be required to produce a perfect level in every direction, and especially in trenches for walls; nor may this be done by replacing loose matter, but the level must be produced on the solid or undisturbed bed. A good excavator will dig and throw out, of common soil, into a basket or wheelbarrow, 8 or 10 yards per diem; but of stiff clay or firm gravel not more than 6 yards.

When the excavation has to be dug to a depth about the height of a man it will be necessary to strut the ground to prevent its falling in, especially if it be of a sandy, loose, or watery nature. This is done by placing on each side of the cutting upright planks against the soil, which may be either open or close, according to the quality of the soil, and against these one or more horizontal waling pieces secured by horizontal cross pieces or struts, and wedging up as necessary. On these struts are formed the landings or stages on which the lowest workman throws the soil he digs up, which is then again thrown up by a second man to another stage or to the surface, according to the depth. Sometimes the soil is hoisted in baskets or tubs raised by a windlass worked by hand, or by a horse-run. When the work has been executed for which the excavation was prepared, the digger has to fill in over and around it, carefully ramming the soil to prevent inequalities on the surface by the soil sinking, and to prevent water soaking in which might affect the foundations.

Brickwork.

Tools. The tools and implements employed by the bricklayer are the trowel, plumb-rule, rod, level, square, bevel, line-pins and lines, raker, jointer, crow-bar, pick-axe, and rammer, together with a hod and spade for his labourer. Besides these there are sundry others, as an axe, saw, and rubstone, used in cutting and gauging bricks, and some which are peculiar to tiling and paving. A pug-mill and screens for mixing and tempering mortar, and tubs and pails for water, are also auxiliaries of great importance.

In ordinary practice the bricklayer's scaffolds are carried up with the walls, and are made to rest on them. Having built up the walls as high as he can reach from the ground, he plants a row of poles, which vary in height from 30 to 40 and even 50 feet, parallel to and at a distance of about 4 feet 6 inches from the walls, and from 10 to 12 feet apart. To these, which are called standards, are attached by means of cords other poles called ledgers, horizontally and on the inside, with their upper surface on a level with the highest course of the wall yet laid; and on the ledgers and wall short transverse poles, called putlogs or putlocks, are laid as joists to carry the floor of scaffold boards. These putlocks are placed from 4 to 6 feet apart, according to the length and strength of the scaffold boards; and the ends which rest on the walls are carefully laid on the middle of a stretcher, so as to occupy the place of a header brick, which is inserted when the scaffolds are struck after the work is finished. On the floor of the scaffold thus formed the bricklayer stands, and the materials are brought up ladders to him by labourers in hods from the ground below; or they are hoisted up in baskets and buckets by means of a pulley-wheel and fall; or by the horse-run, which is more generally used, formed of a level pathway in which the horse moves, drawing up the load by the intervention of snatch blocks and guide wheels; or by the now usual hoisting-machine, worked by men, horses, or steam-power. The mortar is placed on ledged boards about 3 feet square, at convenient distances; and the bricks are strewn on the scaffold between the mortar boards, leaving a clear way against the wall for the bricklayers to move along unobstructedly. The workman then recommences the operation of bricklaying, beginning at the extreme left of his course, and advancing to the right until he reaches the angle or quoin in that direction, or the place where his fellow-workman on the same side may have begun. Thus he goes on with course after course until the wall is as high as he can conveniently reach from that scaffold, when another ledger is tied to the poles, another row of putlocks laid, and the boards are removed up to the new level. The ledger and most of the putlocks, however, remain to give steadiness to the temporary structure, and so on to the full height of the wall, the poles being pieced out by additional lengths as may be required. If a scaffold be very much exposed, and run to a great height, it must be braced. This is done by tying poles diagonally across on the outside to the standards and ledgers, and it may be further secured by tying the ends of some of the putlocks to the ledgers; but an outside scaffold should never be attached in any way to the building about which it stands. A scaffold should never be loaded heavily, as well on account of the work as of the scaffold itself; for the putlocks resting, as they do, on single bricks, in a green wall, they exert an injurious influence on it, which every additional pound weight on the scaffold must necessarily increase, and the putlocks themselves are liable to be bent or broken. A constant and steady supply of bricks and mortar on the part of the labourers, without overloading the scaffold at any one time, should be strictly required. Sca-

The suspended scaffold is a very ingenious contrivance, by which pointing and other external repairs of a house can be performed at a comparatively small cost, and without interference with the thoroughfare. The front can also be painted by the same means. Although known at least Su-

before 1825, it is only of late years that this scaffold has been much used. A couple of planks are secured side by side to form a platform, which is guarded by a railing all round to prevent the workmen falling off. To iron bands are secured pulleys and ropes, passing over other pulleys made fast to two or more beams projecting out of the upper windows, or secured to the roof-timbers, by means of which the workmen employed can raise or lower the scaffold to any position where it is wanted to get access to the work to be done.

Brickmaking.—The manufacture of bricks forms the subject of a separate article. See p. 279 of the present volume.

Mortars and Cements.—A few observations on the composition of mortars and cements for bricklaying will be necessary here. Mortar is of two kinds,—common mortar, or that mixture of lime and sand ordinarily used in building; and hydraulic mortar, or that which will set under water. Cement is a name given to the produce of certain argillaceous stones, after calcination, which will set rapidly in the air, becoming a hard adhesive substance in a short time, and will also set under water, both without admixture of any other substance. The name is given, too, to certain artificial imitations of these substances, possessing the same properties; and besides, to various bituminous or oleaginous compositions, used in building for similar purposes.

Pure lime, which is an oxide of a metal called calcium, does not exist in a natural state. It is, however, found abundantly in the conditions of carbonates and subcarbonates, in chalk, and in the various other descriptions of limestones. Its chemical qualities and analysis will be described under the proper headings in this work. Limes are generally classed, since the publication of the work of Vicat, as—(1) rich limes, (2) poor limes, (3) limes slightly hydraulic, (4) hydraulic limes, and (5) eminently hydraulic limes. In treating of mortar we have to deal with the first two of this division. The first operation is to drive off the water, which all limestones contain in a greater or less degree, and the carbonic acid gas, which is done by calcining or burning in a kiln at red heat; this must be kept up for several hours, care being taken to avoid any approach to vitrification. By this process it is slightly diminished in bulk, loses nearly half its weight, and becomes caustic lime. The lime is next converted into a hydrate by a process called "slaking," or throwing pure water over it from time to time till it hisses and cracks with considerable force and some noise, gives off a large quantity of hot vapour, and falls into a powder. The rich limes, which are the purest oxides of calcium, increase to double their bulk in the process. The poor limes swell to a much less degree. The hydrates thus formed absorb water, and easily take the form of a paste. They contain rather less than one-third water to two-thirds lime. In this state, if treated with pure water, frequently renewed, every particle of the rich limes, and very nearly the whole of the poor limes, will be taken up in solution. In the process of slaking too much water should not be used, as it "drowns" the lime, according to the expression of the workmen. When in the form of paste it begins to absorb carbonic acid, which is always present in air in considerable quantities, and gradually to crystallize again, and so to harden. If the air be excluded from the hydrate of pure lime, it may be kept for almost any length of time. Alberti (lib. ii. cap. 11) says that he once discovered some in an old ditch, which from certain indications must have been there 300 years, and was as soft as honey or marrow, and perfectly fit for use.

The rich limestones give a white lime, which easily slakes, and increases in bulk; but it is curious that though the stones differ so much in outward appearance and in texture, the lime, if they be well burned, is the same. The softest chalk and the hardest rag-stone or marble yield an equally good lime, the calcium which they contain being the same mineral. But as chalk generally contains water, irregularly distributed in some places and not in others, and as it does not exhibit the change that marble or stone does, it is frequently unequally burned, and therefore slakes imperfectly. It is said by Higgins (*Mortars and Cements*, p. 29), however, that lime made from chalk absorbs carbonic acid more rapidly than that made from stone; but experience does not seem to warrant this conclusion. Poor limestones are those which contain silica, magnesia, manganese, or metallic oxides. In consequence of this they are more liable to vitrify in burning, and do not slake so freely. The lime is generally of a browner colour than that from rich limestones, which is said to be a proof of the presence of the above-named metallic oxides. If, however, they be ground so as to facilitate the slaking of every particle, and if used immediately being made up, poor limes produce a mortar which becomes harder than that from the rich limes, and which resists water better. In fact, works where the latter have been used have been found to fail entirely by the action of running water, which, as before has been said, will continue to remove the whole of a rich lime particle by particle.

Poor lime stones.

It is found that the mixture of some kind of hard matter in particles or granules facilitates the setting of mortar, and renders it harder and more adhesive than when used alone, besides the saving of limestone and expense of burning. The harder this material and the sharper the particles the better, as the brick or stone has always some irregularities on the surface, into which these angles or sharp points may enter, and form what is called a key. The substance most generally used is sand, which is classed as river-sand and pit-sand. The former is usually preferred, as it is more free from earthy matters, particularly soft loams or clay. Mortar made with sand containing one-seventh or one-eighth part of fat clay moulders in winter like marl,—a circumstance which proves the propriety of freeing from clay the sand used in mortar. If pit-sand be used it should be well washed. Scarcely any material is better than crushed quartz, or flint, from the sharpness of the angles of the particles; in fact, it is said that very sharp sand, with an inferior lime, will make a more adhesive mortar than soft sand with the best lime. The practical mixing of mortar will be noticed further on. Where sand is scarce, other materials are sometimes used, the principal and cheapest of which is burned clay. The Romans used this extensively in the form of pounded tile. At present the custom is to throw up clay mixed with fuel in loose heaps, to burn it slowly, and then to grind it in a mill with a proper quantity of lime. The French writers at one time asserted that burned clay, if not equal to pozzuolana, was very nearly so; and large quantities were used as hydraulic mortars at various public works. Where the water was fresh, as at Strasburg, the work stood very well; but where these mortars were exposed to the action of sea-water, they failed and went to powder in three or four years. Vicat gave great attention to the subject; and though he attributed much of the fault to the imperfect carbonization of the materials, it appears with but little doubt there is some inherent difference between the pozzuolanas and other volcanic products and those produced artificially. After long investigation, Vicat was of opinion that this failure was due to the quantity of hydrochloride of magnesia always present in sea-water; but in what way this affected the burned clay and not the volcanic products he was unable to explain.

Sands.

Other materials.

Burned clay.

A very excellent mortar, much used by engineers in

tunnels, is composed of one part of moderately hydraulic lime, one part of coal ashes, one part of burned clay, and two parts of sharp sand. The vitrified refuse of furnaces, called slag, and the scoriæ from the iron-works, have also been crushed and used instead of sand; and with lime, slightly hydraulic, produce good mortar. The former is preferred to the latter, as having sharper and harder particles, and containing much less iron. Coal cinders have been used, and seem to have some hydraulic properties; they should, however, be employed with caution, for it is considered they make the lime "short." Wood cinders are too alkaline to be used with safety.

The vitrified and calcined products of volcanoes make most excellent materials for mortars, particularly where required to be eminently hydraulic. The principal of them is the pozzuolana, which abounds in Italy. It is called so from being found in great abundance at Pozzuoli, near Naples, and is, in fact, the basis of all the best Roman mortars, ancient as well as modern. It is usually sent to England from Civita Vecchia. It varies in colour from reddish brown to violet red, and is sometimes greyish; it has a roughly granulated appearance, and sometimes resembles a cinder in texture, and has frequently a spongy appearance. Acids have little effect on it, and it is not soluble in water. A similar earth is found in the centre of France. But one long known in this country comes from the village of Brohl, near Andernach, on the Rhine; this is called tarrass or trass. These materials have a wonderful effect in rendering even the rich limes eminently hydraulic, and in less proportions improving the hydraulic limes. Vicat says, these mortars begin to set under water the first day, grow hard in the third, and in twelve months are as hard as the bricks themselves. The mixture of common lime with these materials, according to the French writers, should be 1 of pounded lime to $2\frac{1}{2}$ of pozzuolana, or to 2 of trass; or 1 of lime to 1 of sand and 1 of pozzuolana.

In addition to the hydraulic limes, which have been thus described, there is a peculiar class of stones, which, when burned and pulverized, may be used as mortar, without admixture of sand or any similar substance; and which will not only set rapidly under water, but will acquire an unusual degree of hardness and tenacity. These are called natural cements. Mr Parker is supposed to have been the inventor; at any rate, that gentleman took out a patent about sixty years ago for what he called Roman cement. His materials were the argillo-calcareous nodules, or septaria, found in the Isle of Sheppey, and commonly called bald-pates. They contain about 70 per cent. of carbonate of lime, about 4 per cent. of oxide of iron, 18 per cent. of silica, and 6 or 7 per cent. of alumina. The process is simply to break the stones into small pieces, and burn them in running kilns with coal or coke; they are then ground to a powder, and headed up into casks for use. The success of Parker's cement led to experiments in other places, and the same process was carried on with other argillo-calcareous nodules, as the septaria at Hawick; those in Yorkshire, which produce the cement called Atkinson's; and those in the Isle of Wight, which produce the Medina cement. Similar substances were also discovered, and the same processes carried on in France and in Russia. All these cement-stones effervesce with acids, and lose about one-third of their weight in burning. Parker considered that the more the stones were burned short of absolute vitrification the better; but this is not the practice in the present day, though, no doubt, sound in theory. When taken from the kiln these stones will not slake without being pulverized; and if kept dry, and not exposed to the air, the cement will be good almost any length of time; but it rapidly absorbs both water and carbonic acid if not carefully closed up, and falls back into a state of subcarbonate, from which it is said it may be recovered by fresh burning, but it is doubted whether it is ever so good as on the first calcination. The great utility of these cements, and the expense of obtaining the stone, induced manufacturers to endeavour to discover some method of making an article by artificial means which should resemble the natural cements. Mr Frost seems to have been the first who attempted it on a large scale; but though he was assisted by the science of General Pasley, the results did not come up to the expected standard. Of course, the object was to produce an argillo-calcareous substance containing the same chemical qualities as the natural nodules, which might be burned in kilns as they are. The attempt to combine argil in the form of burned clay, to be mixed with lime instead of pozzuolana, had partially failed, as has been stated above. The experiments conducted by General Pasley, and by Vicat at Meudon in France, were all based on the principle of mixing together, in a mill, with a quantity of water, masses of chalk and clay, just as the brickmakers do for the production of malm bricks, but in the proportion of about four of the former to one of the latter. The fluid mixture is run out into shallow receivers, and when dry is cut into small blocks or lumps, and burned exactly as the natural nodules are. The difficulty was to give the materials the full degree of calcination short of vitrification. A successful result seems to have been at last attained by the inventors of the Portland cement, so called from its near resemblance to Portland stone in its colour. It not only possesses the property of setting more quickly, and has greater powers of cohesion than the natural cements, but it may be used with a superabundance of water in the form of grout, which they cannot be; above all, it seems to resist the action of sea-water beyond all others; and it is proof against water when used as a mortar in setting brickwork, and in the composition of concrete for foundations. It also forms a very superior cement for plasterer's work. A prepared patent carbonate (Westmacott's patent) is used in combination with chalk, grey, and all other limes. All the carbonic acid being removed from the lime in its burning, 75 per cent. of this acid is restored by its mixture with the prepared patent carbonate, and its induration immediately commences, instead of the lime gaining the carbonic acid by atmospheric influence through a lengthened period. It is used as a quick stucco for rapid plastering; and as a carbonated lime for external use it is in the course of a few days converted into a stone mortar.

Selenitic mortar is the name given to a composition lately invented by Major-General Scott. He was the first to observe, about eighteen years ago, that a limestone capable of conversion by burning into a hydraulic lime might furnish a good cement by simply allowing a small portion of sulphuric acid gas to pass into the kiln during the burning of the lime. Having found difficulty in carrying out this process, he now mixes with the water used in the preparation of the mortar a small quantity of sulphate of lime (*i.e.*, plaster of Paris, or gypsum) or green vitriol. It has the advantage, when used for plastering, of allowing the setting coat to be applied in forty-eight hours after the first coat has been put on. This mortar is said to save half the lime, is four times as strong, and sets in one quarter of the time required by common mortar. The lime will take six parts of sand, and is said to be an excellent substitute for Portland cement for concrete at less cost.

Asphalt, or mineral pitch (see ASPHALT), has lately come into extensive use for paving, for covering the backs of arches, or rendering the walls of basements where wet is likely to soak through, also as a damp-course over the footings of walls to prevent the rise of damp, and for lining cisterns and tanks to prevent the escape of the fluid. The best qualities are the Val de Travers and the Seyssel,

both obtained from France. In using asphalt for paving, a bed of concrete, made of the best hydraulic lime, is first prepared, and made fair at top by a rendering of similar mortar. The asphalt will not dissolve with heat by itself, but will calcine in the caldron. A small quantity of pure mineral pitch is therefore first put in; when this is hot the asphalt is added, and soon dissolves; a quantity of powdered stone-dust is then stirred in, and a small portion of quicklime. The mixture in its melted state is then laid on the bed of concrete (which must be quite dry), and spread close and fair, some sand being sprinkled over the top and well trowelled in. The best proportions are said to be about 2 pints of mineral pitch to 10 ℔ of asphalt and one-fourth bushel of stone-dust. Another method of forming a paving is to place on the concrete a layer about 3 inches in thickness of hot asphalt in powder, and then to ram it down with hot iron rammers, until it has come to its proper consistency; it is then finished as usual. This has been lately much used for roadways in the city of London and elsewhere. The same material has been compressed into tiles about 6 inches square; and these laid on a good foundation. A very inferior imitation is made by mixing a quantity of sharp sand with gas-tar, heated in a caldron, and then adding some quicklime. This may do for rendering walls, &c., to keep out wet, but it is of very little use as paving. Gravel coated with tar, and then laid and set in tar, rammed down, and sanded over, makes a very good pavement for ordinary footpaths.

As before noticed, particular attention must be paid to cleansing the sand to be used for mortar of every particle of clay or mud that may adhere to or be mixed up with it. Sea-sand is objectionable for two reasons: it cannot be perfectly freed from a saline taint, and the particles are moreover generally rounded by attrition, caused by the action of the sea, which makes it less efficient for mortar than if they retained their natural angular forms. Lime should not be slaked until the moment it is to be mixed up with the sand in mortar, but the sooner that is done after it is burnt the better. The proportion of lime to sand generally taken, and the best, is one to three; but if both the materials be of good quality, that is, if the lime slake freely, and become a fine pungent impalpable powder, perfectly clear from argillaceous or any other foreign matter, and the sand be clean and sharp, one part to four is enough; more is injurious. The ingredients should be well mixed together, and with just as much water as will suffice to make the compound consistent and paste-like. Of late years, in lieu of sand, burned clay, as above noticed, has been much used in localities where it is difficult to obtain the former material. This is ground up with lime in a mill, but unless very great care is taken in its manufacture the result is a very poor substitute for sand and lime mortar; and brick and lime rubbish have also been used in like manner, with an equally inferior result. Rain or other soft water should be used for the purpose of making mortar, and not spring or hard water, though any other may be preferred to what is brackish even in the slightest degree. Higgins recommended that lime-water should be used in preference to pure water. A quick-setting cement, such as those which are commonly used in building in England, and known as Parker's or Roman cement, and Portland cement, can only be mixed or gauged as it is required for use. A bricklayer will keep a labourer fully employed in gauging cement for him alone. It is mixed with sand in the proportion of from about two or three to about five or six of sand, to one of the cement, according to the quality of the latter; and the labourer as he gauges on one board supplies the mixture to the bricklayer fit for use on another board, a spadeful at a time; it must then be applied within half a minute, or it sets and is spoiled and wasted, for it should never be worked up again.

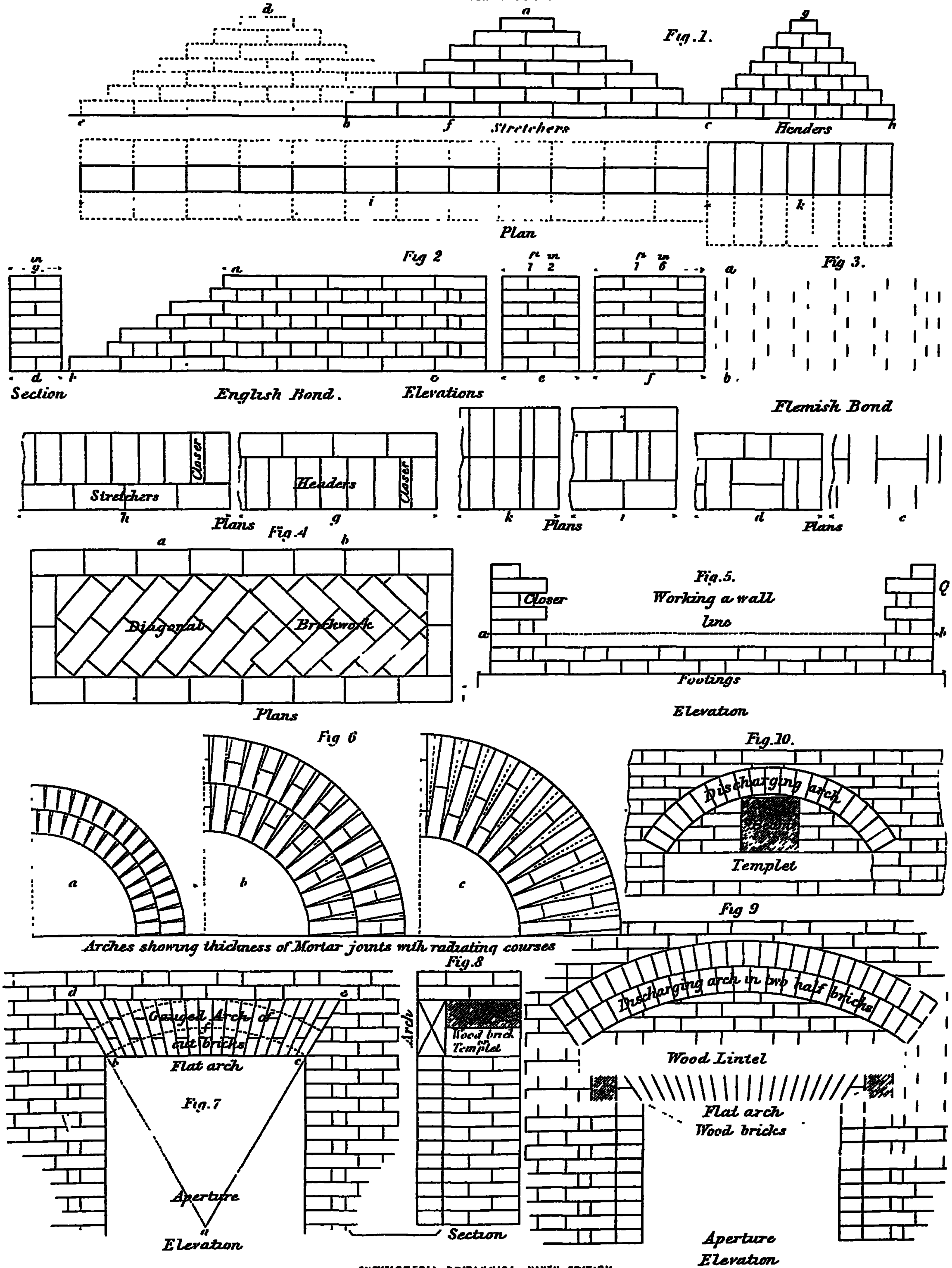
The average size of bricks in England is a fraction under 9 inches long, $4\frac{1}{2}$ inches wide, and $2\frac{1}{2}$ inches thick; and in consequence of this uniformity of size, a wall of this material is described as of so many bricks in thickness, or of the number of inches which result from multiplying 9 inches by any number of bricks; a 9-inch or one-brick wall; a 14-inch or one-brick-and-a-half wall ($13\frac{1}{2}$ inches would be more correct, in fact, for although a joint of mortar must occur in this thickness, yet the fraction under the given size of the brick is enough to form it); an 18-inch or two brick wall, and so on. Brick walls.

The great art in bricklaying is to preserve and maintain a bond, to have every course perfectly horizontal, both longitudinally and transversely, and perfectly plumb (which last, however, may not mean upright, though that is the general acceptation of the term, for the plumb-rule may be made to suit any required inclination, as inward against a bank, for instance, or in a tapering tower); and also to make the vertical joints recur perpendicularly over each other, which is vulgarly and technically called keeping the *perpends*. By bond in brickwork is intended that arrangement which shall make the bricks of every course cover the joints of those in the course below it, and so tend to make the whole mass or combination of bricks act as much together, or as dependently one upon another, as possible. The workmen should be strictly supervised as they proceed with it, for many of the failures which have occurred may be referred to their ignorance or carelessness in this particular. The object of bonding will be understood by reference to the diagram, fig. 1, Plate XX. Here, it is evident, from the arrangement of the bricks, that any weight placed on *a* would (supposing, as we are obliged to suppose, that every brick bears equally, throughout its whole length, a stress laid on every part of it) be carried down and borne alike in every course from *b* to *c*; in the same manner the brick *d* is upborne by every brick in the line *e f*, and so throughout the structure. But this forms a longitudinal bond only, which cannot extend its influence beyond the width of the brick; and a wall of one brick and a half or two bricks thick, built in this manner, would, in effect, consist of three or four half-brick-thick walls, acting independently of each other, as shown in the plan at *i* in the diagram under fig. 1. If the bricks were turned so as to show their short sides or ends in front, instead of their long ones, certainly a compact wall of a whole brick in thickness would be produced; but the longitudinal bond would be shortened one-half, as at *g c h*, and a wall of any greater thickness, in the same manner, must be composed of so many independent one-brick walls, as at *k* in the plan before referred to. To obviate this, to produce a transverse, and yet preserve a true longitudinal bond, the bricks are laid in alternate courses of headers and stretchers, or of ends and sides, as shown in fig. 2, thus combining the advantages of the two modes of arrangement *a b c* and *g c h* fig. 1, in *a b c* fig. 2. Each brick in fig. 2 showing its long side in front, or being a stretcher, will have another lying parallel to it, and on the same level, on the other side, to receive the other ends of the bricks showing as headers in front, which in their turn bind, by covering the joint between them, as shown in the end of such a wall at *d*. Thus a well-bonded 9-inch or one-brick wall is produced. The end elevations of the same wall at *e* and *f* show how the process of bonding is pursued in walls of one and a half and two bricks thick, the stretcher being abutted in the same course by a header,—thus, in a 14-inch wall, inverting the appearance on the opposite sides, as seen at *e*, and producing the same appearance in an 18-inch wall, as at *f*. In the diagram

Bricklaying. Bonding. Plate XX.

BUILDING

BRICK WORK



W. & A. K. Johnston.

under fig. 2, at g, is the plan of a 14-inch wall, showing the headers on one side, and the stretchers on the other, and at h is the plan of the course immediately above it, in which the headers and stretchers are inverted; at k and i are shown in the same manner the plans of two courses of an 18-inch wall. This is called English bond. Thicker walls are constructed in the same manner by the extension of the same principle.

glish
d.

sers.

But a brick being exactly half its length in breadth, it is impossible, commencing from a vertical end or quoin, to make a bond with whole bricks, as the joints must of necessity fall one over the other. This difficulty is obviated by cutting a brick longitudinally into two equal parts, which are called half headers. One of these is placed next to a whole header, inward from the angle, and forms with it a three-quarter length between the stretchers above and below, thus making a regular overlap, which may then be preserved throughout; half headers so applied are technically termed closers, and are shown next the upright angle of the wall fig. 2, and the first joints inwards from the square ends by the headers in the plans at g and h. A three-quarter stretcher is obviously as available for this purpose as a half header, but the latter is preferred, because, by the use of it, uniformity of appearance is preserved, and whole bricks are retained on the returns. In walls of almost all thicknesses above 9 inches, to preserve the transverse, and yet not destroy the longitudinal bond, it is frequently necessary to use half bricks; but it becomes a question whether more is not lost in the general firmness and consistence of the wall by that necessity, than is gained in the uniformity of the bond. It may certainly be taken as a general rule, that a brick should never be cut if it can be worked in whole, for a new joint is thereby created in a construction, the difficulty of which consists in obviating the debility arising from the constant recurrence of joints. Great attention should be paid to this, especially in the quoins of buildings, in which half bricks most frequently occur; and there it is not only of consequence to have the greatest degree of consistence. but the quarter bricks used as closers are already admitted, and the weakness consequent on their admission would only be increased by the use of other bats, or fragments of bricks.

mish
nd.

Another mode of bonding brickwork, which may be supposed to have arisen from the appearance of the ends of a wall according to the former mode of arrangement (see e and f, fig. 2), instead of placing the bricks in alternate courses of headers and stretchers, places headers and stretchers alternately in the same course, fig. 3. The plans below this at c and d are of two courses of a 14-inch wall, with their bond, showing in what manner the joints are broken in the wall horizontally as well as vertically on its face. This is called Flemish bond. Closers are also necessary to this variety of bond; half bricks also will occur in both, but what has been said with reference to the use of them in the former applies even with more force to the latter, for they are more frequent in Flemish than in English, and its transverse tie is thereby rendered less strong. Their occurrence is a disadvantage which every care should be taken to obviate. The arrangements of the joints, however, in Flemish bond, presenting a neater appearance than that of English bond, it is generally preferred for external walls when their outer faces are not to be covered with some composition; but English bond should have the preference when the greatest degree of strength and compactness is considered of the highest importance, because it affords, as we have already noticed, a better transverse tie than the other.

o Flemish
nd
road

Mr W. Hosking was the first to notice (in the last edition of this work) that what is in England called Flemish bond is unknown in Flanders, and is practised in the British Isles alone. In Flanders, Holland, and Rhenish Germany, which are bricklaying countries, no kind of bond is found but what is known in England as English bond. But it has lately been noticed that the mediæval brick buildings in the north-east of Germany are worked in Flemish bond, or as it is there called "cross-bond;" and it is also to be seen at Brussels in work of about the end of the 18th century. Many of the buildings designed by Inigo Jones in England, and perhaps all of those by Sir C. Wren, are executed in Flemish bond, which name, it has been suggested, might have been derived from the word "flemishing" used by workmen, and thus applied to brickwork as meaning work better "finished off" than the other kind.

Herring-
bone wor

It has been attempted to improve the bond in thick walls by laying raking courses in the core between external stretching courses, and reversing the rake when the course recurs. This obviates whatever necessity may exist of using half bricks in the heading courses, but it leaves triangular interstices to be filled up with bats, as is shown in Plate XX. fig. 4. This represents the plan of 36-inch or three-brick wall with raking courses at a, between external ranges of stretchers, and lying on a complete course of headers, and at b a wall of the same thickness herring-boned; courses of headers would bed and cover this also, and, in the second course above, the raking or herring-boning would be repeated, but the direction of the bricks reversed. It will be seen that the latter demands, in addition to the triangular filling in bats at the outer ends of the diagonally placed bricks, half bricks to fill up the central line of interstices, rendering herring-boning more objectionable in that particular, though it has some advantages over simply raking, or thorough diagonal courses in other points. Neither mode should, however, be had recourse to for walls of a less thickness than three bricks, and that indeed is almost too thin to admit of any great advantage from it.

Walls to
be vertical
and level

Not second in importance to bonding is, that the brickwork be perfectly plumb, or vertical, and that every course be perfectly horizontal, or level, both longitudinally and transversely. The lowest course in the footings of a brick wall should be laid with the strictest attention to this latter particular; for the bricks being of equal thickness throughout, the slightest irregularity or incorrectness in that will be carried into the superimposing courses, and can only be rectified by using a greater or less quantity of mortar in one part or another, so that the wall will of course yield unequally to the superincumbent weight, as the work goes on, and perpetuate the infirmity. To save the trouble of keeping the plumb-rule and level constantly in his hands, and yet to insure correct work, the bricklayer, on clearing the footings of a wall, builds up six or eight courses at the external angles (Plate XX. fig. 5), which he carefully plumbs and levels across, and from one to the other. These form a gauge for the intervening parts of the courses, a line being tightly strained from one end to the other, resting on the upper and outer angles of the gauge bricks of the next course to be laid, as at a and b, and with this he makes his work range. If, however, the length be great, the line will of course sag; and it must therefore be carefully set and propped at sufficient intervals. Having carried up three or four courses to a level, with the guidance of the line, the work should be proved with the level and plumb-rule, and particularly with the latter at the quoins and reveals, as well as on the face. A smart tap with the end of the handle of the trowel will generally suffice to make a brick yield what little it may be out, while the work is so green, and not injure it. Good workmen, however, take a pride in showing how correctly their work will plumb without tapping. In work which is circular on the plan, both the level and the plumb-rule must be used, together with

a gauge-mould or a ranging trammel, for every course, as it must be evident that the line cannot be applied to this in the manner just described. For every wall of more than one brick thick, two men should be employed at the same time, one outside and the other inside; one man cannot do justice from one side even to a 14-inch wall.

aying ricks. Bricks should not be merely *laid;* every brick should be rubbed and pressed down in such a manner as to force the mortar into the pores of the bricks, and so produce absolute *adhesion.* Moreover, to make brickwork as good and perfect as it may be, every brick should be made damp, or even wet, before it is laid, especially in hot weather, otherwise it immediately absorbs the moisture of the mortar, and, its surface being covered with dry dust, and its pores full of air, no adhesion can take place; but if the brick be damp, and the mortar moist, the dust is enveloped in the cementitious matter of the mortar, which also enters the pores of the brick, so that when the water evaporates their attachment is complete. To wet the bricks before they were carried to the scaffold would, by making them heavier, add materially to the labour of carrying; in dry weather they would, moreover, become dry again before they could be used, and for the bricklayer to wet every brick himself would be an unnecessary waste of his time; boys may therefore be advantageously employed to dip the bricks on the scaffold, and supply them in a damp state to the bricklayer's hand. A watering-pot with a fine rose to it should also be used to moisten the upper surface of the last laid course of bricks preparatory to strewing the mortar over it. In bricklaying with quick-setting cements all this is of even more importance; indeed, unless the bricks to be set with cement are quite wet it will not attach itself to them at all.

Mortar joints and beds. As mortar is a more yielding material, used in brickwork merely for the purpose of making the detached portions of the staple adhere, by filling up their interstices and excluding the air, and the object is to produce as unyielding and consistent a mass as possible, no more should be used than is sufficient to produce the desired result. No two bricks should be allowed to touch, because of their inaptitude to adhere to each other; and no space between them should be left unoccupied by mortar which may produce adhesion. When the bricks are a fraction under $2\frac{1}{2}$ inches thick, four courses of bricks and mortar, or brickwork, are usually allowed 11 inches in height; and if they are fully that thickness, four courses are allowed $11\frac{1}{2}$ inches. The result of thick beds of mortar between the bricks is, that the mortar is pressed out after the joint is drawn, on the outside, in front; and being made convex instead of slightly concave, the joints catch every drop of rain that may trickle down the face of the wall, and are thus saturated; the moisture freezes, and in thawing bursts the mortar, which crumbles away, and creates the necessity, which is constantly recurring, of pointing the joints to preserve the wall. The diagram, fig. 6, shows the section of a 9-inch wall, with the joints on the side *a* as drawn, and on the side *b* as bulged, in consequence of the quantity of mortar in them yielding to the weight above. This, too, is in addition to the inconvenient settling, which is the consequence of using too much mortar in the beds. In practice, bricklayers lay the mortar on the course last finished, and spread it over the surface with the trowel, considering that it will fill the space between the bricks of that course, in addition to what they may have placed in the edges of the outside joints; but the mortar ought not to be so thin as to fall into the joints by its own weight; &c., unless they press it down, half the height of the space between the bricks remains unoccupied, and the wall is consequently hollow, incompact, and necessarily imperfect. To obviate this, it is common to have thick walls grouted in every third or fourth course; that is, mortar made liquid, and called grout, is poured on and spread over the surface of the bricks, that it may run in and fill up the joints completely. This, at the best, is but doing with grout what should be done with mortar; and filling or flushing up every course with mortar requires very little additional exertion, and is far preferable. It also assists in making the house warmer and drier, by preventing the passage of wind or damp through the joints. Grouting.

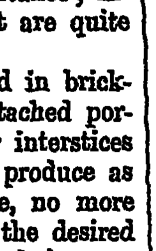


Fig. 6.

All the walls of a building that are to sustain the same floors and the same roof should be carried on simultaneously; under no circumstances should more be done in one part than can be reached from the same scaffold, until all the walls are brought up to the same height, and the ends of the part first built should be racked back, as at *a b*, Plate XX. fig. 2, and not carried up vertically with merely the toothing necessary for the bond, as at *a b*, fig. 3. Walls be carried up together.

Brickwork should never be carried on in frosty weather, nor even when it is likely that frost will occur before the walls can be covered in or become so dry as not to be affected by frost. Covering an unfinished wall with a thick layer of straw when frost may supervene is a very useful precaution; and on the straw weather-boarding should be laid, to prevent access of moisture from rain or snow. Merely wet weather may be guarded against by following the directions given above as to flushing every course of the work well up with mortar, so that no interstices be left into which water may insinuate itself, and by covering the walls with boards to act as a coping when the men are not actually at work on them; the joints in the face of a wall that is not to be plastered in any way should be protected in this manner with great care. Frost.

After the footings of a wall (above noticed) have been brought up to the level of the finished surface of the ground, or to the underside of the joists of the lowest floor, there should always be introduced a damp-proof course, intended to prevent that rise of damp from the soil in the brickwork which is the cause of so much disfigurement and injury to buildings. This damp course is formed in various ways, as a layer of asphalt, or asphalt canvas, or some similar material. One of the best and most usual, as the materials are always at hand, is formed of two courses of slates, well breaking joint, and set in cement. Another is Taylor's or Jennings's patent stoneware damp course, which being pierced horizontally admits air to the space under the floor and thus ventilates it. Damp-proof course.

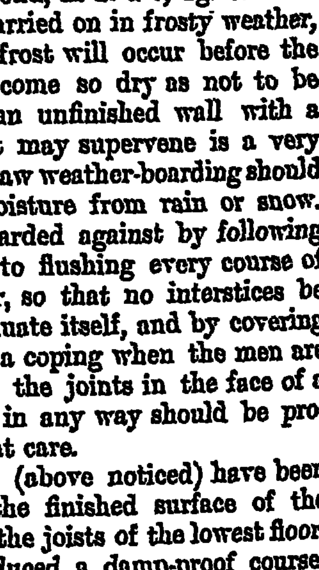


Fig. 7.

Where the ground would come against the walls of a basement story, it is requisite, in order to keep them dry, either to form an open drain or area, or to make what is called a dry area. This is done by building up against the soil a thin wall of brickwork not less than 8 inches from the main wall, and either straight or curved, and covering it over above the ground with stone or slate, as in fig. 7. Thus any water coming through the thinner wall falls down, and is conveyed away or soaks through the bottom. This thinner wall requires Dry area.

support from the main one, and the cavity has to be ventilated.

Partition walls. Besides the outer or main walls of a house, there are interior walls, or partitions as they are called. These in large structures are always executed in brickwork; in smaller ones they are usually constructed of timber; and these timbers are often filled in between the uprights by brickwork formed of bricks laid flat or on edge according to the thickness of it. A plate of wood is occasionally introduced to strengthen the work, which is then plastered over This is called a brick-nog partition. In many of the model lodging-houses in London the partition walls have been constructed a half brick in thickness in good mortar, for the whole height of the building, the floor joists being fixed against them to steady them.

Hollow walls. Another sort of wall consists of two skins of brickwork with a few inches between them; this is called a hollow wall. The two skins, either both of half a brick thick, or the outer one of one brick and the inner one of half a brick, are tied together by iron band-ties at various intervals. These when straight are sometimes found to transmit the wet blown through the outer facing to the inner one, so a bend or loop is formed in the centre of the tie, which throws off the water. This hollow space tends to make the houses both dry and warm, but it is said to form receptacles for insects, &c. An addition to such walls has been lately made by a series of these looped ties supporting a course of slates placed not quite vertical but sloping back slightly. The next course of ties is built in at such a level that it fixes the top of this first course of slate in place, and provides a starting for the next course. Thus, in the heart of the wall there is a continuous surface of slates, slightly overlapping at joists and at beds, and so placed that whatever moisture blows through the outer skin is not able to penetrate, but will trickle down the slates to the bottom of the cavity in the hollow wall. This is one of the many building patents of Mr John Taylor.

Materials and labour for rod of brickwork. A rod of brickwork will consume about 4500 bricks, though the number will be a few more or less than this, as the bricks happen to be below or above the average size, and as the joints are made thicker or thinner. The quantity of mortar, it is evident, will be affected by the latter consideration also; but in London it is generally reckoned at from ninety to a hundred striked bushels to the rod, or from four to four and a half cart-loads, each containing about one cubic yard. The labour on a rod of brickwork may be done on an average by a labourer in four days; this, however, does not include making and turning the mortar, nor scaffolding. Many things will, however, affect the time in which the work may be performed, both of the bricklayer and his labourer; the former can do one-fourth as much more, at the least, in walls which are to be plastered, as in those in which he has to keep the perpends and draw the joints, &c., and more in thick walls than in thin ones; and the capability of the latter will depend, inversely, on the rate at which the former can proceed, on the distance he may have to carry the bricks and mortar to the foot of the ladder, and mainly on the height he has to carry the materials up the ladder. In great heights, however, the materials should be hoisted.

Roof tiling. Tiling being much less in vogue than formerly, in consequence of the better appreciation of the superior qualities of slate for covering roofs, and the moderate cost at which slates are now furnished to the builder, it no longer maintains its separate artificer, but is performed, when it is required, by the bricklayer. Tiling is for the most

Plain tiles. part of two sorts—plain tiling and pantiling. Plain tiles are simple parallelograms, generally about $10\frac{1}{2}$ inches in length, 6 inches wide, and $\frac{5}{8}$ of an inch thick; and each tile has a hole pierced through it near one end, to receive the oak pin by which it is hooked to the lath. The tiles are laid in mortar and sometimes in hay, or moss, on the laths, which in England are of oak or fir, with an overlap of 6, 7, or 8 inches. The greatest overlap or smallest gauge makes the securest work, though it does not present so good an appearance externally as a longer gauge does; and it requires, moreover, a greater number of tiles and laths, thereby adding materially both to the weight and the cost. The great overlap and the mortar (or hay or moss) are both necessary to prevent the rain and snow from driving in between and under the tiles, especially when of a low pitch. Plain tiling requires the pitch of the roof to be at an angle of at least 50°, and is one of the heaviest coverings that can be used, though it is at the same time one of the warmest. The tiles, however, readily and rapidly absorb moisture, which they communicate to the laths and rafters under them, to the serious injury of both the latter; and the mortar in which they are set requires to be frequently pointed, the constant atmospheric changes to which it is exposed occasioning it to crumble and fall away in no long time. Terro-metallic tiles are made with projections at the back to catch on the laths, in lieu of pegs. Italian tiles have been made in England since about 1840, and are occasionally used. They are slightly curved, fit easily one into another, and have a horizontal indentation across the upper part to prevent the wind drifting the rain over the head of the tile. They have either wide or narrow vertical rolls. Taylor's new roofing tiles have a plane surface with slightly turned up edges at the sides, and a lump on the surface near the upper edge to prevent the upper tile slipping. The cover tile is of a similar size and form. They are recommended as half the weight of the common tiling; they are about as light as slating, and may be laid to nearly as flat a pitch. Other sorts of tiles.

Pantiles. Pantiles are parallelograms of irregular surface, straight in the direction of their length, which is $13\frac{1}{2}$ inches, but twisted in the transverse section. Measuring the whole surface across, a tile is 9 inches wide, but in a right line from point to point not more than 7, and its thickness is half an inch; a small tongue or lip is bent down at one end from its flatter convexity, on the under side, to hook it to the lath by, instead of a wooden pin through it, as in a plain tile. Pantiles are set dry or in mortar, on laths. They are not laid side by side, but overlap laterally as in fig. 8; consequently all the overlap they have longitudinally is 3 or 4 inches only, or enough to prevent rain and snow from driving up under the upper, over the end of the lower tile; and hence pantiling is but little more than half the weight of plain tiling.

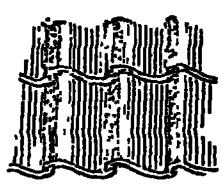


FIG. 8.—Pantiling.

It is, however, a much less warm covering for houses, and is more liable to be injured by violent gales or gusts of wind than the latter is; but again, it presents a far more pleasing appearance to the eye. Pantiling will not bear a much flatter pitch than the other. It is greatly improved by being pointed on the inside with lime and hair. Sometimes, indeed, the whole of the work is, as we have said, set in mortar; but this mode has disadvantages to which pointing internally is not liable, and its superiority in other respects is questionable. In both pan and plain tiling large concave tiles are used to cover the hips and ridges of a roof. These are not generally made to overlap each other in any situation, but are set in mortar, and fastened with nails and hooks fitted for the purpose, and driven into the woodwork of the roof. In addition to these an ornamental ridging or cresting is often introduced. A variety of patterns are now made for this purpose. Another form of

pantile very useful for common purposes is the Bridgewater tile; it is rather wider than the common tile and has a double roll, being about $16\frac{1}{2}$ inches wide and 14 inches long.

As plain tiling is heavier than slating, the plates and rafters of the roofs have to be made stouter than is necessary for slates, consequently the expense of the roofing is added to, supposing that the same thickness of wall be sufficient. The tile also imbibes one-seventh part of its weight or about 5 oz. of water in ten minutes, and takes many days to dry again thoroughly, this necessarily tending to deteriorate the timbers.

ping. When the top of a brick wall is not protected by a roof, it must be covered or coped in some manner, or it will soon be destroyed by the weather. Sometimes this is done by means of a course of bricks set across it on their edges in cement, and called a barge course, but it is a very imperfect covering, for water will trickle down the face of the wall on both sides, as the coping brick can be no longer than the thinnest wall is in thickness. Two double courses of plain tiles may be put side by side under the barge course, making a projection over each face of about $1\frac{1}{2}$ inch, as shown in *fig. 9*. This is much better than the barge

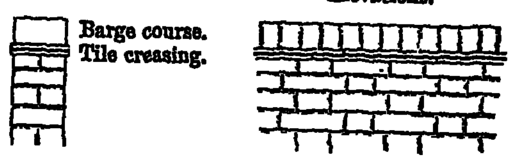


Fig. 9.—Coping.

course alone; but still the covering receives *no inclination* outwards to throw the water off; the upper surfaces are all horizontal. The same objection exists to *foot-paving* tiles, which are also used as a coping; but *none of these* methods is available for any wall above 9 inches in thickness. Stone coping, therefore, which may be made of sufficient width, and be both weathered and throated, is much to be preferred. One of the greatest faults in the modern practice of building, both architecturally as a matter of taste, and practically as a matter of prudence, is, that these copings, and cornices which serve as such, do not project sufficiently to protect the wall from the weather. A massive and well-projected cornice on a wall serves as a roof or pent-house to it; and, besides imparting great beauty to the plainest structure, protects the wall from the premature decay of its upper part especially, and of the joints generally, if it be unplastered brickwork, which thereby calls for the frequent repetition of pointing. Effective and pleasing cornices and blocking-courses may be formed with uncut bricks alone; and these, set in cement, would, with judicious management, add materially both to the appearance and durability of brickwork, without the foreign aid of either the plasterer or the mason. Figs. 10 and 11 show two of the approved modes of forming plain copings in brickwork to garden and other walls.

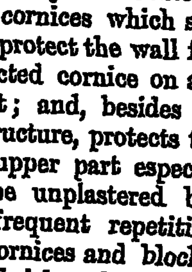


Fig. 10.

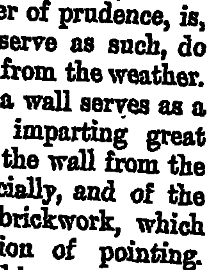


Fig. 11.

Brick Copings.

From the injury which accrues to the joints of brickwork through bad management in its execution and imperfect protection when executed, arises the necessity, so frequent at the present day, of pointing. Sometimes frost will have supervened before the surfaces of the joints in a wall are dry; consequently, the mortar bursts and peels away, and the whole then requires to be pointed. Preparatory to this operation the scaffold, if it has been struck, must be re-erected, the mortar raked out of the joints to a depth of about $\frac{3}{8}$ of an inch, or deeper if the injury have reached further;—this can be done by a labourer;—a bricklayer then goes over the whole with a hard hair brush and water to cleanse and moisten the joints; and then, with mortar prepared for the purpose, he carefully fills them all up, and neatly draws them with his trowel. This mortar must be of the best quality; it is generally compounded with a certain proportion of forge or smith's ashes, which gives it a blue tinge, and adds greatly to its power of resisting the action of the weather. Cement is sometimes used instead of this blue mortar. If peculiar neatness be required, every joint is marked with a narrow parallel ridge of a fine white putty, in the composition of which bone-lime forms a principal ingredient. The former is called flat-joint, and the latter tuck-pointing. If it be an old wall that requires pointing, a scaffold must be erected before it; and where the putlocks cannot be rested on window-sills and the like, half bricks are generally drawn from the wall to make rests for them, and restored again when the work is done. The former process is then gone through with a common wall; but if it require tuck-pointing, the whole surface is well washed, and then coloured to look like new brickwork, before the pointing is done. The gauged arches over the windows and doors are always coloured, and the joints drawn with peculiar neatness. If in the original building of the wall the perpends have not been preserved, that is, if the vertical joints have not been made to fall perpendicularly in the alternately recurring courses, the workman in pointing stops up the old joints, which are irregular, with putty of a brick colour, and forms false new ones in the proper places.

Arches in brickwork are plain, rough-cut, or gauged. Arches.
Plain arches are built of uncut bricks, and the bricks being Plain.
parallelopipeds, an arch built of them must be made out *with mortar*; that is, the difference between the outer and inner periphery of the arch requiring the parts of which an arch is made up to be wedge-formed, as in fig. 12

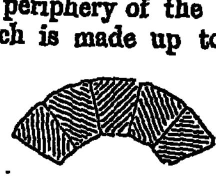


Fig. 12.

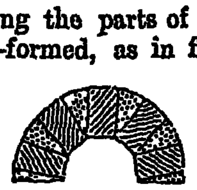


Fig. 13.

which the brick is *not*, the difference must be made in mortar, as in fig. 13, so that the inner or lower angles of bricks used for this purpose should all but touch. The mortar should be more consistent than that used in ordinary walling; and the centre on which an arch of this kind is set or built should not be struck or removed until the work is thoroughly hard, or rather all such arches should be set in cement which will harden immediately. In consequence of this inherent defect in uncut-brick arches, in extensive continuous works, such as sewers, tunnels, vaults, &c., it is advisable to make them in thin independent rings of half-brick or one-brick thick, as the case may be; that is, a 9-inch arch should be in two half-brick arches, as at *a*, fig. 6, Plate XX., and an 18-inch arch in two one-bricks, as at *b*, each arch in the latter case being bonded in itself as in a common 9-inch wall with headers and stretchers. It is evident that, by this mode of structure, a greater quantity of the solid material comes into the back or outer ring or arch than into the lower one; and if they *had* been bonded together into one arch, as at *c*, all that difference must have been made up with *mortar*. Moreover, whatever pressure comes on the outer ring is carried by it directly to the inner or lower, from whose joints, however, the mortar cannot escape or be pressed out, the *inner* angles of the bricks, by meeting, preventing it *below*, and the bricks of the upper arch, which conveys the

pressure, are themselves opposed to the back of the same joints, so that its power of resistance is made equal to that of the bricks themselves, except at the ends; which, in such works as we have supposed, are remote, and may be protected by the use of cement in their joints, whilst mortar is used in the rest. Rough arches are those in which the bricks are roughly cut with an axe to a wedge form, and are used over openings, such as doors and windows, when the work is to be plastered on the outside, or in plain back fronts, outhouses, garden-walls, &c., when, however, they are neatly pointed with what is called a tuck or tucked joint. Semicircular and elliptical arches are generally made plain, or without cutting the bricks; but arches composed of a smaller segment of a circle (vulgarly and technically called *scheme* arches), if not gauged, are cut or axed. Very flat arches are distinguished by the term camber, from the French *cambrer*, to round like an arch. It is arches of this kind which are generally employed over windows and doors in external work, and they too are either cut or gauged. Gauged arches are composed of bricks which are cut and rubbed to gauges and moulds, so as to form perfectly fitting parts, as in masonry. Gauging is equally applicable to arches and to walling, as it means no more than the bringing every brick exactly to a certain form, by cutting and rubbing, or grinding it to a certain gauge or measure, so that it will exactly fit into its place, as in the finer works of masonry. Gauged brickwork is set in a putty instead of common mortar, but it is seldom used except for arches in the fronts of houses, &c., which are to be neatly finished. These are for the most part straight, and are generally from 11 to 12 inches in depth, or the height of four courses of brickwork. Their value as arches will be best understood by reference to the diagram, fig. 7, Plate XX., by which it appears that all the material between the soffit of the straight arch or head of the opening *b c*, and the dotted line *b f c*, is useless, the intrados or soffit of the really efficient part of the arch being at that dotted line itself. This is the arc of an angle of 60°,—its chord, the width of the opening, being the base of an equilateral triangle constructed on it, and the joints are the radii of a circle whose centre is at *a*. *b d* and *c e*, the continuations of the sides of the triangle or radii *a b* and *a c*, are technically termed the skew-back of the arch. Sometimes the arc is made under a more acute angle, in which case the skew-back is less, that is, the external angles *c b d* and *b c e* are less obtuse; a smaller unavailable portion of the arch is thus left between the arc and its chord, but that portion is less securely retained under the flatter segment, because the joints or radii diverge less, or are more nearly parallel. These gauged arches being, as they for the most part are, but a half brick in thickness, and not being tied by a bond to anything behind them—for, indeed, almost the whole, if not the whole, of their height is occupied behind by the reveal and the wooden lintel—require to be executed with great care and nicety. It is a common fault with workmen to rub the bricks thinner behind than before, to insure a very fine joint in front. This tends to make the work bow outwards; it should rather be inverted, if it be done at all, though the best work is that in which the bricks are gauged to exactly the same thickness throughout. The same fault occurs when a gauged arch is inserted in an old wall, on account of the difficulty of filling up with cement the space behind the bricks. Fig. 8, Plate XX. is a transverse section of fig. 7, and the gauged arch, lintel, &c., in it show the total disconnection of the gauged arch with any surrounding brickwork to which it might be bonded. The absurdity of constructing arches circular on plan, especially in a thin unbonded shell of bricks, is so clear as hardly to require notice.

Plates and wood-bricks.

It is generally held that nothing but its own components should be admitted into a brick wall, except what is absolutely necessary for its connection with the other parts of a building, such as wall-plates and wood-bricks (and that these should be avoided as much as possible), templets, lintels, &c. Wall-plates are applied to receive the ends of the joists, and distribute the weight of the floor to which they belong equably along the walls. If the joists tailed singly on the naked bricks, their thin edges would crush those immediately under them, and the rest of the brickwork would escape immediate pressure altogether. Wall-plates may be avoided by the use of framed floors, which are carried by a few large beams, under whose ends stout pieces of timber or stone, 2 or 3 feet in length, are placed. These supports are intended, like a wall-plate, to distribute the weight over a considerable part of the wall, and prevent the necessity of placing the beam on the naked friable bricks, and are called templates. As bond timbers and wood-plates are now interdicted by the Buildings Act in London, the joists have to be tenoned into trimming joists carried by brick, stone, or iron corbels.

Lintels.

Lintels are used over square-headed windows and doors, instead of arches in brickwork. They are useful to preserve the square form and receive the joiner's fittings, but they should always have discharging arches over them, and should not tail into the wall at either end more than a few inches, that the discharging arch be not wider than is absolutely necessary. Fig. 9, Plate XX., indicates the elevation of the inside of part of an external wall with a window in it, and shows the lintel over the opening with a discharging arch over it, and wood-bricks under its ends, on the jambs of the opening. Discharging arches should be turned over the ends of beams, and templets also, as in fig. 10. They may generally be quadrants of a circle or even flatter, and should be turned in two or more half bricks over doors and windows, and other wide openings, but over the ends of beams they need not be in more than one half brick.

Discharging arches over openings.

Wood-bricks.

Wood-bricks are used to prevent the necessity of driving wedges into the joints of brickwork to nail the joiner's work to. They are pieces of timber generally cut to the size and shape of a brick, or portion of one, and worked in as bricks in the inner face of a wall, where it is known the joiners have occasion for something of the kind. This is principally in the jambs of the windows and doors for their fittings, and along the walls, at proper heights, for the skirtings or wainscotting, as the case may be. The use of bond timbers in brick walls is objectionable because of their liability to shrink and swell, to decay, and to be set on fire; and in England the use of timber in walls has, since the extension of the manufacture of iron in these countries, been in a great degree superseded by that metal in the form known as hoop iron.

Bond timber.

Hoop iron.

Thin and narrow strips of this metal are laid in the bed joints of mortar, at intervals more or less frequent according to the nature and character of the work, with the best effect in respect of compactness and consequent strength. An improvement on the straight band has been introduced by Mr Tyerman, whereby a notch is made and the tongue bent down, which coming at each hollow of the bricks tends to afford a better hold on the mortar.

Brick and ashlar work.

It will be generally found that a brick wall built with mortar and faced with ashlar has settled inward to a less or greater extent, as the work has been more or less carefully performed. Indeed, in the nature of things it cannot be otherwise, unless the brick backing be worked in some cement which sets and hardens at once; for the outer face is composed of a layer of unyielding material, with few and very thin joints, which perhaps do not occupy a fiftieth part of its height, while the back is built up of an infinity of small parts, with fully one-eighth its height

of joints, which are composed of material that must both yield to pressure and shrink in drying. Some part of the ill effect attendant on this is obviated by the bond-stones, which tail in or run through the wall, and tend to keep the discordant materials together; but still much of it remains. And besides this, the internal or cross walls, which have no stone in them, will either settle down and shrink away from the external walls, or drag them inward, as they happen to be well or ill bonded or tied. For these reasons, brickwork built in this manner with masonry should be executed with exceedingly well-tempered mortar, made with no more lime than is absolutely necessary to cement the particles of sand together, and the sand again to the bricks, worked as stiff as it can be, and laid in as thin courses as may be to answer the purpose required of it. Above all, work of this kind must not be hurried, but allowed time to dry and shrink as it goes on. In some large edifices the brickwork is carried up and completed, and after a sufficient time has elapsed for the work to have settled, the ashlaring is carried up and worked in with the bond stones set in the brickwork for the purpose.

Discharging arches under openings.

Discharging arches over vacuities having been disposed of incidentally, we have now only to speak of them under openings, in which situation their use is to distribute the superincumbent weight equally over the substructure, or along the foundation as the case may be. For this purpose the arch is inverted, as shown in fig. 4, Plate XXI.; and by means of it the weight brought down by the piers is carried along the footings, which are thus equally borne upon throughout their whole length. Arches of two half bricks are indicated here, that being sufficient for ordinary purposes, and to develop the principle; in large and heavy works, arches of three half bricks, and even greater may be judged necessary. Any arc between a quadrant and a semicircle may be used with advantage; but an arc of less than 45° cannot be recommended for the inverted discharging arch under piers. Arches require abutments whether they are erect or inverted; this is often forgotten when inverted arches are used.

Chimneys and flues.

Not the least important part of the bricklayer's art is the formation of chimney and other flues. Great tact is required in gathering-over properly above the fire-place, so as to conduct the smoke into the smaller flue, which itself requires to be built with great care and precision, that it be not of various capacity in different parts, in one place contracted to a narrow straight, and in another more widely expanded, and so on. There is now often introduced at the level of the mantel, a plate with an opening in it through which the smoke ascends. This, which is called a chimney-hopper or chimney lintel, is very useful not only to ensure the proper gathering of the flue, as the brickwork of the flue is formed at once upon it, but as a substitute for the usual register, and it also renders needless the usual iron chimney bar required to support the breast. It is absolutely necessary that flues be of a certain magnitude, but the bore should be regulated by the size of the fire-place, or rather by the quantity of smoke to which it is required to give vent. For large kitchen fires it is considered best to have two flues.

Chimney hopper.

Practical men differ as to whether a tapering flue, or an enlarging flue is best for carrying away smoke. They are usually made of one size throughout. Of late years cylindrical earthenware tubes have been used with advantage, and of a smaller bore than the common 9-inch by 14-inch capacity. With glazed tubes it has been found that the soot falls down with thunderclaps and other strong vibrations. Flues of brick are plastered or pargetted with a mortar in which a certain proportion of cow-dung is mixed, which prevents it from cracking and peeling off with the heat to which it is exposed. The part brought out into the room from the wall, and over the opening, is called the breast. The flooring in the opening is called the hearth, fig. 8, Plate XXI.; it is set on the bricks or stones of the wall, and is usually of stone, although cement and iron plate are sometimes used. The slab is that part of the floor of a room which is immediately before the fire-place, and along the extent of its front. In basement rooms, this slab is supported by a brick wall brought up from the ground; but in upper rooms the slab is supported by a flat half brick arch called a brick trimmer, which is turned from the chimney breast under the hearth on one side to the trimmer joist on the other, which is generally made somewhat thicker than the other joists for this purpose. The chimney-piece which comes in front is fixed by the mason after the carpenter's work is done.

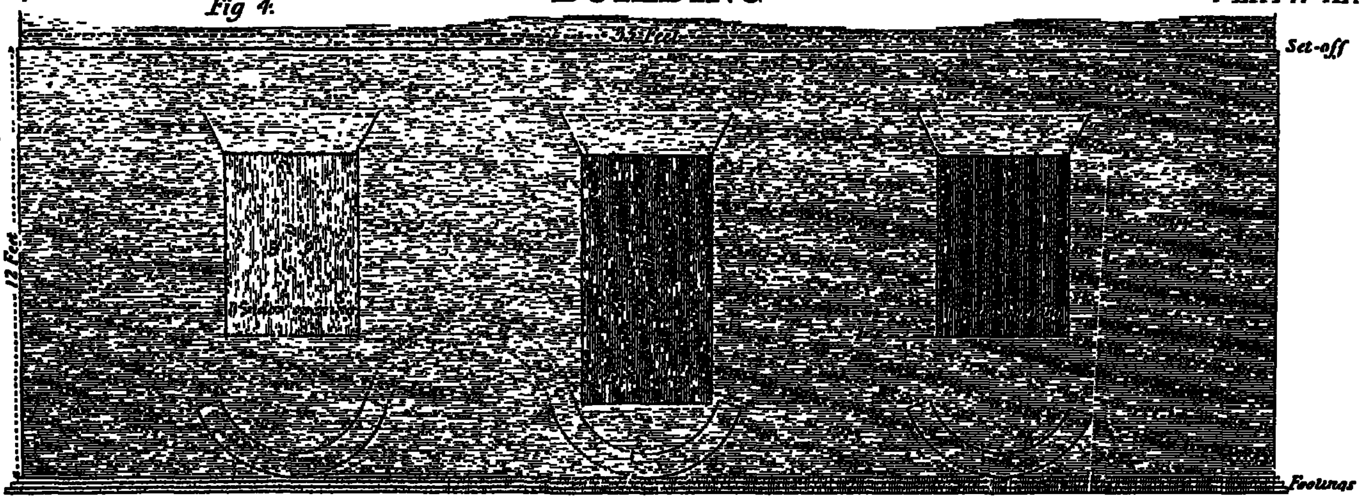
Causes of smoky chimneys.

The plate above mentioned assists in ensuring a proper draught to the flue, and preventing a smoky chimney. These are frequently caused by want of sufficient air to feed the fire, which must be supplied from the room itself or by a tube brought from the outside of the building. Another cause of smoke is too short a funnel, especially if the flue be a large one, as formerly built for sweeping by boys. Every fire-place must have its own flue. Other causes are—one fire overpowering the other, when there are two in one large room, or two rooms communicating by a doorway, or when the tops of chimneys are commanded by higher buildings, or by a hill, so that the wind sometimes blows almost perpendicularly into the tops of the chimneys that lie in its way and beats down the smoke. A down-draught is usually produced by the difference of the external atmosphere from that in the room; this often brings down the smoke of a neighbouring chimney; it can occasionally be obviated by raising one of them, or by fixing on it one of the exhausting pots now manufactured for the purpose. The bad construction of fire-places is another cause of smoky chimneys, the throat being too large for the fire. We shall not attempt to describe the many patent and other inventions submitted for curing these nuisances, but what is known as Billings's terminal must be excepted. It consists of a low conical top about a foot high, placed on the flue, and screened on each side by a terra-cotta baffler, rising somewhat higher than the pot; the wind striking the former is thrown upwards and assists in extracting the smoke; the latter prevents the smoke of one flue being blown down the adjoining ones in the same stack. The common terra-cotta pot with louvre sides is also useful and ornamental.

Paving, brick.

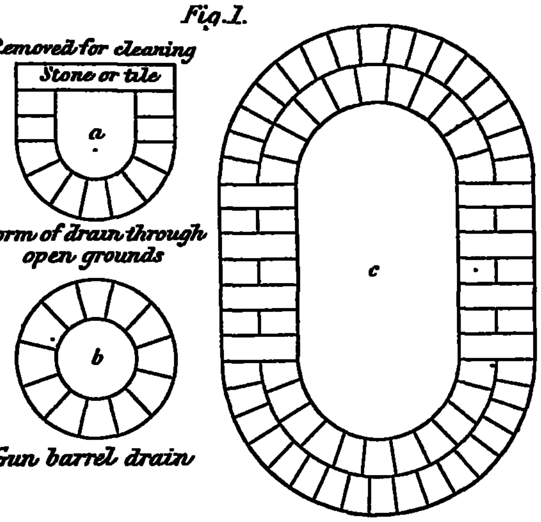
Brick and tile paving is performed by the bricklayer. Brick-paving is either flat or on edge, in sand or in mortar or cement. Brick flat-paving in sand, that is, with the bricks laid on their broadest surfaces, and bedded in and on dry sand, is very slight and fragile, and brick flat-paving set and bedded in mortar is very little better; for if the soil on which the paving is laid be light and sandy, the bricks are easily displaced by being pressed unequally; and if it be clayey it will probably be moist, and the thin porous brick absorbing the moisture, will generally become saturated, and present a damp unwholesome floor. Paving with bricks on their edges, however, forms a much better floor, and is preferable to a stone paving, if the latter be laid on the ground without the intervention of footings. Brick-on-edge paving in sand is generally used in beer cellars, pantries, dairies, stables, &c., as its numerous open joints allow wasted or discharged fluids readily to escape; and it is both cool and dry under ordinary circumstances. In mortar or cement, bricks on their edges form a sound, dry floor; the smallness of the surface exposed by each brick in this manner leaves them, of course, less susceptible of partial pressures, and the depth from the soil to the

Fig 4.



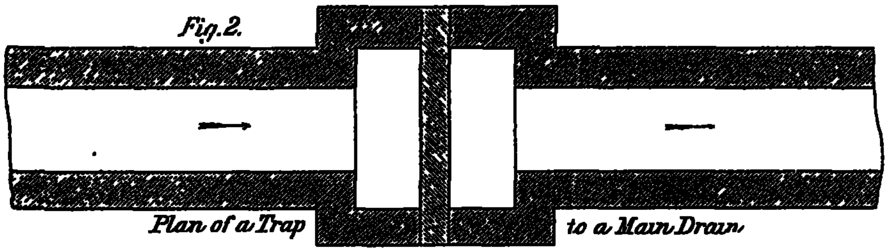
Elevation showing openings with discharging arches under them

Fig. 1.



Section of a Main Drain or Sewer of a form not now recommended.

Fig. 2.



Plan of a Trap to a Main Drain

Fig. 3 Section of a Trap

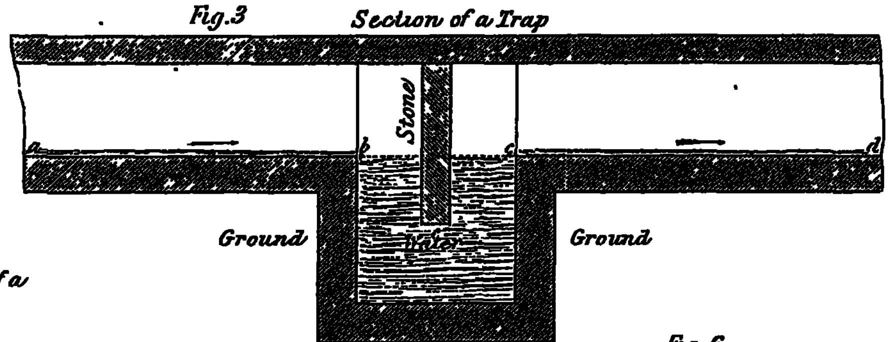
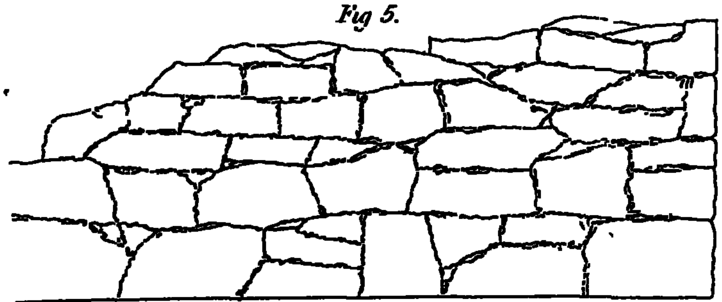
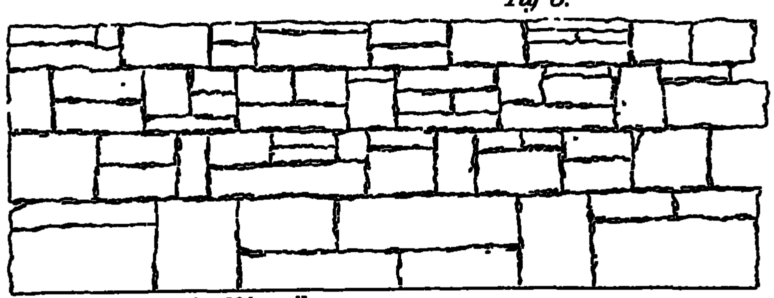


Fig 5.



Uncoursed rubble walling.

Fig 6.



Coursed rubble walling.

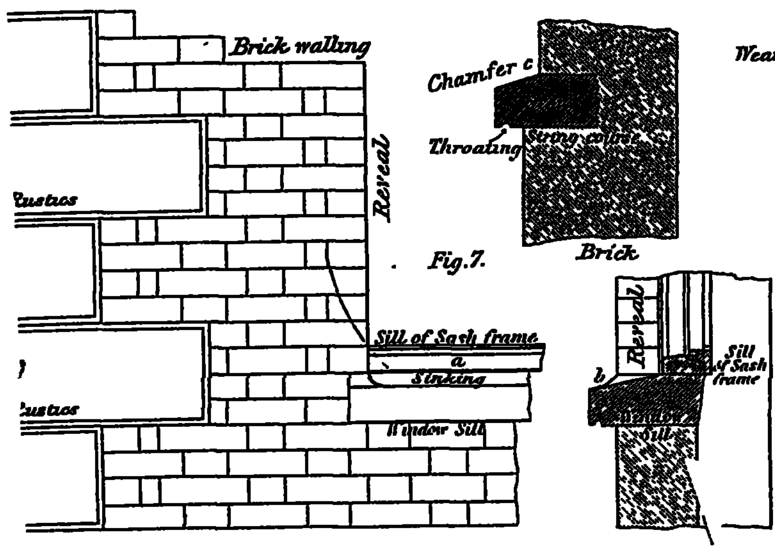
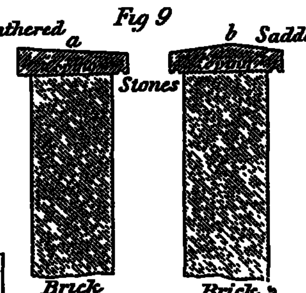
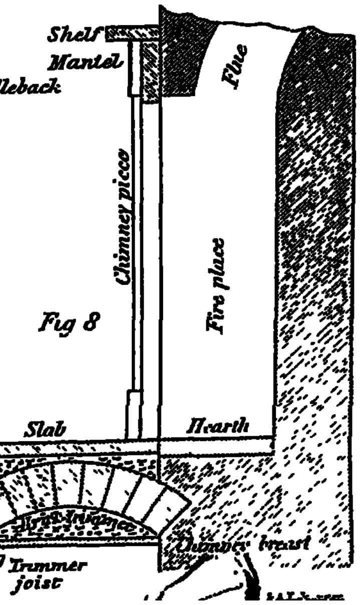


Fig 9





surface is such that damp rarely shows through. The paving brick differs from the common brick only in thickness, its dimension in that direction being rather less than 2 inches, instead of $2\frac{1}{2}$ inches, and in being rather harder and more compact.


FIG. 14.—Paving of Dutch Clinkers.

ch cers. Dutch clinkers are paving bricks, smaller and much harder than the English, and of a light yellow colour; they are 6 inches long, 3 inches wide, and $1\frac{1}{2}$ inch thick, and are always set on edge and herring-boned, that is, instead of being placed in parallel lines, they are set at right angles to each other, as in fig. 14, yet with a perfectly even face. ing in Paving tiles are made $9\frac{1}{2}$ inches and $11\frac{1}{2}$ inches square, though they are called 10-inch and 12-inch or foot tiles respectively, the former being 1 inch, and the latter $1\frac{1}{2}$ inch thick; they are set in courses, as stone paving would be, the alternating courses breaking joint. A sort of tiles called terro-metallic are manufactured for stabling and similar purposes.

amen- nd r tiles. Here may be mentioned the extended manufacture of ornamental tiles. The tiles formed in intaglio and enamelled, similar to those used by the Moors in Spain, have enabled the architect to break through the monotonous surface of brick buildings, and to introduce ornamental forms and colour without the necessity of resorting to plaster and stucco. From the geological position of London and many other towns, bricks must always be the prevailing material for building purposes; such means, therefore, for the safe introduction of colour and ornament are especially desirable and should be carefully studied. With this, too, has come the extended use of ornamental brickwork by the introduction of moulded bricks of all forms, and of many colours, together with a material of a like nature, by which decorative work of a more ornamental character can be obtained, namely terra-cotta, or prepared clay moulded or wrought and then burnt in a kiln. Tiles as above referred to are made for mosaic and tesselated pavements in plain colours (some being enamelled), for halls, footways of landings, conservatories, &c., also glazed tiles for hearths, and white and toned tiles, with the encaustic tiles of many colours, for walls. The former are manufactured of all sizes, so that by the combination of certain forms and colours an endless variety of patterns are obtainable. For pavements they require to be carefully set in cement on concrete, and in cement on walls.

ers and ins. Sewers and drains which are not cylindrical should be built with concave bottoms; this keeps the stream more together, and enables it the better to carry its impurities along with it, whereas a flat-bottomed drain offers a large surface for the particles of soil to attach themselves to, and the stream of water being more scattered is less efficient in force. Drains near houses, and in other places where it may be necessary to open them at any time, may be of the form of which *a*, fig. 1, Plate XXI. is a section, with a flat covering of stone paving, or large paving tiles, set and jointed with cement. Gun-barrel drains, of 9-inch or 12-inch diameter, as at *b*, are the best in exposed situations, because they are the strongest; but as there is no mode of cleaning, if they are too long to be raked, but by breaking them up, they should not be employed except with a considerable fall and a frequent or constant stream of water through them, as from a pump trough, rain-water trunks, &c. They are constructed on a barrelled centre of wood, which the bricklayer drags on as he advances with his work, finishing as he goes. No drain should have an inclination or fall of less than one-quarter of an inch to a foot; and where the stream is infrequent and dull, as much more would be a great advantage. Large sewers, urs. which are accessible from the ends, or from side entrances, for men to clear or remove any accidental obstructions, are best made circular, elliptical, or egg-shaped, as in fig. 15 The last two shapes are generally preferred, because in proportion to the capacity the height is greater. The form in fig. 15 maintains the greatest possible depth with a small quantity of fluid, and combines this qualification with those of great strength to resist external pressure and large capacity with a given amount of materials. The form shown at *c*, fig. 1, Plate XXI., is now disused, though it was long advocated for sound workmanship and regular joints. A rate of fall of 1 in 120, or 1 inch in 10 feet, is desirable, although less will suffice for a main sewer.

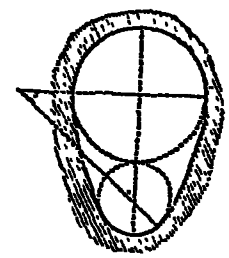


FIG. 15.—Section of Sewer.

Pipes or hollow cylinders of well-made and well-burnt glazed stoneware form the most efficient house-drains. Pipe drains. Such pipes are put together with great accuracy with sockets, so as to fit spigot and faucet fashion; movable tops are provided so as to give access to them at any part required, without taking up and relaying the drain from one or other of its ends, as was so often the case with the old brick drain. Proper bends, junctions, syphons, &c., are also made of the same material. In using pipes for drains, it should be borne in mind that a little larger than large enough is better than the reverse of this. No pipes should be laid down for a house-drain of less bore than 6 inches, nor should earthenware be used for drains requiring a greater bore than 12 inches; the material is too weak to allow of more, and the material is not strong enough to stand more than a dead pressure. Glazed stoneware pipes are also employed for small sewers in side streets, or to take off the collected soil and water from a short row of houses into the main brick sewer, and thence to a watercourse or to a reservoir of a main drainage scheme.

In building drains it is of great importance that proper Trap traps should be constructed to prevent the ascent of foul air and the passage of vermin. At every sink there should be a bell-trap, and a well-trap within that, or near the hither end of the drain. Suppose a drain leading from a kitchen or scullery to the common drain of the house, in which it meets that which may come from the water-closet and other places. The bell-trap in the sink itself will prevent the return of smell when it is constantly in use, but it is liable to be left out, broken, or otherwise injured, or it may become dry by evaporation; it is, therefore, necessary to have a trap not so liable to such ordinary contingencies. Let a well be made 18 inches or 2 feet in diameter, square or round, and 2 feet 6 inches or 3 feet deep, across and below the level of the drain, as shown in plan, fig. 2, Plate XXI., and in longitudinal section, fig. 3; it must be built around with brick in cement, and be plastered on the inside with the same material, which will make it capable of retaining fluids. Uprightly across this well, and in the transverse direction of the drain, must be placed a sound piece of paving stone, so long that its ends may be inserted in the sides of the well, as shown in fig. 12, and so wide that its upper edge shall touch the covering of the drain, and that its lower may reach 6 or 9 inches down into the well below the bottom of the drain. Mortar or cement must prevent the passage of air between the upper edge of this trap-stone and the cover of the well and drain, and the trap is complete. The water coming from the sink flows along the drain from *a* to *b* (fig. 3), where it falls into the well, and filling it up to that level it flows on again from *c* in the direction of *d*, to the cess-pool or common sewer from which, however, no smell can return; for the trap-stone

e, the lower half of which is thus immersed in water, completely bars the passage. It is evident, however, that if the well should leak the water in it may fall below the lower edge of the stone, and the efficiency of the trap be destroyed; but if it be made perfect in the first instance, there can be no danger of any inconvenience that a bucket of water thrown into the sink will not cure. It is from the drying up of the fluid in water-traps that uninhabited houses are so frequently offensive. These well-traps form an effectual bar to vermin, and they may, therefore, be advantageously placed at the entrance of water-closet drains, to prevent rats from getting at the soil-pipes, which they will gnaw and destroy if they can get access to them. Internal drains, or those which go through a house, should always pass under the doorways if possible, in external walls at least. If, however, circumstances should render it absolutely necessary that a drain be taken through a wall, an arched ring or bull's eye should be made for it to pass by

Ventilation. All the traps to the drains should be ventilated, as well as the head of the drain itself, by a tube carried up to the top of the house, and away from any opening where the foul air could be blown into any of the rooms. The sewers should also be ventilated, if not by the gully or side gratings, then by a grating placed over them in the centre of the roadway There have been numerous suggestions for ventilating shafts in the lines of main drainage, but nothing beyond a tall lamp-post has been carried out, and no doubt this is sufficient.

Cesspools and tanks. In country houses where the drainage is used for manure to the gardens or land, the drain from the closets may be led into a brick or iron tank or cesspool, the surplus water being carried off by an overflow drain. Cesspools are strongest if made cylindrical, and should be bricked round and domed at the top, with a manhole in it for access, which should be fitted with a stone, having a ring in it by which the stone can be raised. But whether they are made to retain fluids or not is not a matter of consequence, if they be placed in a secluded situation, where, if the object be not to get rid of the waste, there is seldom, at least, any desire to retain it. In towns and cities where the common sewering is as complete as it ought to be, and water-closets are used insteaa of privies, cesspools are unnecessary, as the soil becomes so much diluted by the water that goes down with it, that it flows readily enough through the private drains to the common sewer, and so on with the rest, to the common receptacle. Sometimes, indeed, it may be found necessary to clean out the well-traps before described, but this cannot often occur. Galvanized tanks are occasionally used in some parts of the country, with pumps attached, by which the sewage can be rendered available for the garden. Earth closets on Dr Moule's system, or the cinder-sifting ash closets, are valuable for preventing the waste of an important manure. For workmen's cottages in large towns and villages they must be of great service, but whether they are adapted to a town house, or are applicable on an extensive scale for the relief of town drainage, is a question which still remains unsolved.

Earth closets

Mason-Work.

The word *mason* is derived directly from the French *maçon*, which signifies indifferently a bricklayer or mason. Du Cange attributes the origin of the word to the low Latin *maceria*, a wall; but a more probable derivation is that from the old German *meizan*, to cut. Among ourselves, at present, we reckon three sorts of artificers—rubble or rag-stone masons, freestone masons, and marble masons. This last branch, however, is rather that of the carver or statuary. The art of working or reducing stone to the proper shape for the mason to *set*, *i.e.*, to place them in the walls, &c., has generally been called *stone-cutting*, and depends very much on the nature of the stone for its details. *Stone masonry* is the art of building in stone.

The mason's tools consist of a handsaw, for cutting soft stones; a drag, which is a flat piece of iron wherewith to finish its surface; chisels and gouges for forming mouldings, gauges and moulds for sinking them to the proper forms; a mallet, chisels, tools, and points for working the harder stones; a level, a plumb-rule, a square, a bevel, with rules of various sorts wherewith to try the surfaces in the progressive stages of the work. Granite is brought to a face by the scabbling hammer or granite axe, and the operation is called nidging. In rubbed work a surface is obtained by smoothing it with sand or gritstone. Marbles are polished by being rubbed with the gritstone, then with pumice-stone, and lastly with emery powder. Tools.

Rubble walls are scaffolded with single, and ashlar-fronted or other gauged stone walls with double-fronted scaffolding,—the former tailing one end of the putlocks in the wall, and the other having an inner row of standard poles, and ledgers parallel to the outer, making the scaffold entirely independent of the wall. In some places, however, it is the custom to dispense altogether with an external scaffold in building stone walls, particularly with gauged stones. With light and plain work this may be done without much inconvenience or retardation; but if the work be heavy or delicate, considerable delay and incorrectness result. Sometimes the finer work, such as that to mouldings, flutes, and foliate or other enrichments, is merely boasted or roughed out before the stones are set, and finished afterwards, but this can be done well only from a secure floor or scaffold on which the workman may feel he can move freely and surely. For large and elaborately decorated structures, such as a public building, a mechanical scaffolding has to be erected, by which some economy is effected through diminishing labour, or some emergencies met attendant on the works themselves. Where the face of a stone is worked in the shop and may have some weeks or months labour on it, it becomes a valuable work worth careful handling. Hence the old-fashioned kind of scaffolding, of poles and ropes, has been much superseded by the so-called whole timber or framed scaffold, with its tramway and crab engines aloft. It is usually formed by laying square timbers on the ground to receive similar uprights, which are secured by iron ties to it; on the heads of these are placed horizontal timbers, which are also secured to the uprights, and the whole is kept from changing position by timber struts and braces. On these another range may be erected, and so on to the required height. Tramways are placed on it, and a travelling crane, worked by hand labour or by steam, raises the heavy weights, carries them to their places, and at once deposits them in the work with great ease. By the use of a steam-lift, with a long arm to reach many feet above it, on the first stage of the frame scaffold, no other scaffold is necessary except a slight one for the use of the workmen to set the stone. The clock tower at the Houses of Parliament was built by a scaffold formed of two timbers, Scaffolding.

each 2 feet 3 inches deep and 14 inches wide, running across from side to side, on which rails were fixed to carry a travelling platform of the whole width which went the reverse way. To one side of the first named timbers was suspended a platform which carried the machinery for raising the materials from the bottom up the central shaft; they were then raised on to the traveller which carried them at once to the required spot for fixing. When a certain height of work had been done, the huge timbers were raised by six screw-jacks working together, and rested on the new wall, the jacks being removed and prepared for another raising when necessary. The Victoria Tower was erected on a somewhat similar principle, but having two travellers working upon a circular tramway on a strong trussed framing, the ends of each secured to a central drum. To raise the materials a strong under-trussed parallel framing was formed on one side, which brought them up on the outside of the tower.

Stones used in Building.—It may be useful to give a list of the stones principally used in building, according to their geological formation, with some practical remarks upon each.

Of *igneous rocks* of *volcanic* origin, the varieties which are used on the continent of Europe are those light stones called tufa and pumice, and the stone called peperino. The two former were extensively employed by the Romans in the filling in of vaulting, on account of their great lightness. The latter stone, which is obtained in large quantities near Rome, was used by that people extensively, particularly for substructures, being obtained in large blocks. Of the second division of igneous rocks, the *trappean*, porphyry and serpentine have been used, but chiefly as ornamental coloured stones, and have been generally classed as marbles. Of the third division, the *supersilicated* rocks, granite alone is now extensively employed, not only in engineering works, but in public buildings and dwellings. It is got from the quarries by splitting the blocks with wedges, and is so hard that it cannot be cut by any ordinary saws. It has to be worked first with large hammers, and then reduced by pointed chisels, and consequently is very expensive in building. Machinery is used very largely in cutting and also in polishing it. Some very good specimens come from Cornwall and Devonshire, but by far the best are from Dundee and Aberdeen. A variety of the latter, called Peterhead granite, is only to be equalled by the finest Oriental granites. The Kingstown granite from near Dublin is much used locally.

Of *the aqueous rocks, mechanically formed*, and of the *arenaceous* varieties, gravel is used for concrete, and sand in making mortar. Sandstones and gritstones are very extensively used. These are either laminated, as the York stone, used generally for paving, as it can readily be split into large surfaces of small relative thickness, or compact, as Old Red Sandstones, which stand very well internally, but perish sadly with the weather, as may be seen at Chester Cathedral. The New Sandstones, the best of which is the Calverley stone got near Tunbridge Wells, are easily quarried, but if sawn, the wet saw and sand must be used. The finer grained compact sandstones, which are comparatively free from iron, and form very good building-stones, are very numerous. Such are the Bramley Fall, used for bridge copings, plinths, &c.; the Park Spring, Elland Edge, Whitby, and others, all in Yorkshire; the Hollington in Staffordshire; the Mansfield in Nottinghamshire; and the Minera quarries at Wrexham. A bed of the last is much used at Chester and Liverpool for building purposes, and it has just been introduced into the London market, for which city it is thought it will be very eligible, on account of its lasting qualities; it has been also used at the National Safe Deposit Company's offices in London. Scotland can boast of some of the finest quarries of sandstone, the best, perhaps, being the Craigleith, much used at Edinburgh. The College, courts of law, Register House, Custom-house, Royal Exchange, National Monument, and many churches and private residences there, are built of this excellent material, which has also been extensively exported to Hamburg, Altona, Gothenburg, and other places. Humbie stone has also been much used, both at Edinburgh and at Glasgow, where it forms the Royal Exchange and Royal Bank; it is easier to work than Craigleith. Glamis is also a fine sandstone; the castle there, as well as those at Inverquharity and Cortachy, and Lindertis House, are built of this material. In Fifeshire, at Cullalo, are quarries whence the stones for the monument to Lord Melville at Edinburgh, and that to Lord Nelson at Yarmouth, were obtained. In addition to beauty and durability, these stones have the merit of being capable of receiving the finest and smoothest forms from the chisel of the workman. Another class of sandstones are commonly called *firestones*, as they endure the action of fire better than most others. Of these the best known is the Reigate stone, which is the principal material used at Windsor Castle, Hampton Court, and in many old buildings round London. The Minera stone already mentioned is another.

Of *mechanically-formed aqueous stones* classed as *argillaceous*, the Clunch only is used in building. It may be seen in Ely and Peterborough cathedrals, and many other mediæval buildings, and is a beautiful material for interior carved work, but will not stand the weather.

Of the *aqueous stones* classed as *chemically formed*, there is none of note but the Travertine, or, properly speaking, Tiburtine. This is a coarse grained stone, of warm colour, found in large blocks, and extensively used at Rome, both in ancient and modern buildings, of which the cathedral of St Peter's may be cited as an instance, but it is unknown in England.

Of *aqueous rocks, organically derived*, the *calcareous* claim principal attention. The chief of these are the *limestones*, which are classed as compact, magnesian, or oolitic limestones. Of the first, the best, in the south of England, is that called Chilmark, of which Salisbury Cathedral and Wilton Abbey, and many other fine buildings, have been erected. In the Midland counties the Tottenhoe stone, of which Dunstable Priory, Woburn Abbey, Luton church, &c., are built, is an excellent stone. There is also a stone of high quality got at Hopton Wood, near Worksworth in Derbyshire, used at Chatsworth, Belvoir, Drayton Manor, &c. Ancaster stone, near Sleaford in Lincolnshire, has been used for a number of years; also Ham Hill, near Yeovil, in Somersetshire. Of magnesian limestones we may name the Anston and Bolsover Moor stones, used formerly at Southwell Minster, and lately at the Houses of Parliament; the Tadcaster stones, used at York, Beverley, and Ripon Minsters, and very many other buildings; the Roche Abbey, used at the building of that name, and very many other churches in Yorkshire and Lincolnshire; the Brodsworth, near Doncaster; and the Huddlestone, near Sherburne in Yorkshire. These stones contain a great deal of carbonate of magnesia, from which they take their name, are of beautiful texture, and stand well in the country as building stones, but fail in London.

A very excellent limestone for rough walling, especially for Gothic work, is that called Kentish Rag. It is found in large quantities in the neighbourhood of Maidstone; it is very hard, and is worked with large hammers instead of the saw. Jambs, strings, and mouldings are sometimes worked of it, but the hardness makes the work expensive; these, as well as the quoin stones and dressings, are therefore formed of Caen or Bath or other local stones. Kentish Rag does not answer for interior work.

The most important subdivision of the limestones used in masonry is the *Oolitic*. They are so called because they resemble, when broken, a conglomerate of globular eggs; they are also named roe-stones, from their resemblance to what is called the hard roe of a fish. Very good examples of these are the Barnack stone from Northamptonshire, of which Peterborough Cathedral, Croyland Abbey, Burleigh House, &c., are erected, and the Ketton stone, used at most of the colleges in Cambridge, and at Bury St Edmunds, Bedford, Stamford, Doulting in Somersetshire, and at Wells Cathedral and surrounding churches. But the principal English oolites used in masonry are the Bath and the Portland. The former, as its name imports, is found in the neighbourhood of Bath. The chief quarries are the Box Hill, Combe Down, Farleigh Down, and Corsham Down; all these quarries vary in quality at different depths. The Corsham Down is said to produce the finest in quality, and the Box Ground stone to be the hardest; but everything in the use of this stone depends on the bed selected. Large quantities of a similar stone are imported from Caen, in Normandy. This is more compact in texture than Bath, and therefore fitter for carving, but does not appear to stand our climate so well. The best variety of this stone is said to be the D'Aubigny stone. Almost all these oolites can be sawn with a common dry saw, which saves a great deal in the labour of conversion. But, without doubt, the best of all this class of stones is that from the Island of Portland; for beauty of texture, and for durability, it perhaps exceeds any stone in the world. It seems the only one unaffected by the smoke of London; and therefore the greater number of its buildings, St Paul's among the rest, are of this stone. Being of hard texture, however, it must be sawn by the use of sand and water, and is much more expensive to work than the softer oolites. There are between fifty and sixty quarries on the island. The best are said to be those on the north-eastern side; but, as with all stones, there is good and bad in every quarry, and everything depends on the selection. It is said that when Sir Christopher Wren built St Paul's Cathedral, he had this stone quarried and exposed to the weather on the sea-beach for three years, before he suffered it to be used.

Of *siliceous* stones, flint is sometimes used for rough walling and for ornamental facing with brickwork; but in England this work is done by the bricklayer, and not the mason.

The only remaining class is that of the *metamorphic rocks*, of which the crystalline or saccharine and the serpentinous limestone are used; but these are all species of marbles, used more as ornamental than as constructive building-stones, and need not be dwelt upon here.

Many of the early buildings of the Middle Ages were entirely constructed of masses of concrete, often faced with a species of rough cast. The early masonry seems to have been for the most part worked with the axe and not with the chisel. A very excellent example of the contrast between the earlier and later Norman masonry may be seen in the choir of Canterbury Cathedral. In those times the groining was frequently filled in with a light tufa stone, said by some to have been brought from Italy, but more probably from the Rhine. The Normans imported a great quantity of stone from Caen, it being easily worked, and particularly fit for carving. The freestones of England were also much used; and in the first Pointed period, Purbeck and Bethersden marbles were employed for column shafts, &c. The methods of working and setting stone were much the same as at present, except that, as the roads were then in a very bad state, and in many places the only means of conveyance was by pack-horses, the stones were used in much smaller sizes. The methods of setting out work were, however, different from those of other styles, as might be expected from the difference of forms. As time went on the art of masonry advanced till, in England, in point of execution it at length rivalled that of any country.

From the regular and determined form of bricks, modes or systems for setting or arranging them may be formed, and any workman, by habit and an exertion of memory merely, may become competent to build a brick wall as well as it can be built, but it is not so with stone used in common masonry walling. The workman in this material has for the most part to deal with masses of all forms and of all sizes, and a continual exercise of the judgment is required from him beyond the tact or skill which may be acquired by practice. For this reason workmen are generally less to be trusted to their own discretion in stone building than even in bricklaying. The young mason should be extremely careful to avoid making the beds of stones concave or hollow; for if this be done, in any case where the stones have to bear much pressure, they will flush or break off at the joints and disfigure the work. The best or highest sort of stone walling is the easiest to set; it is that in which the stones are all tooled and gauged in regular parallelogramic figures, to range in courses and suit the thickness of the wall to which they are to belong; and the most difficult to execute properly is that in which amorphous stones are used, the mason being allowed merely to dress them roughly with his hammer or axe, and fit them in as he best can to form the most compact mass: this is called rubble walling.

From the brittle nature of stone, great tact is required in setting, to prop or bear up the longer pieces in every part, or they will break across, and thus occasion more injury than could accrue if the whole mass had been made up of small pieces. Very long lengths, therefore, should be avoided, even in regular tooled courses, with which the bearing is or should be perfectly even, and a settling down of the work itself is hardly to be feared. There is a certain medium which may be preserved; and although the object is obviously, in stone as in brick walls, to form a compact mass, as unbroken into parts as possible, a mason will act judiciously in breaking a very long stone into two or more shorter ones, and working them in that state, though he thus makes two or more additional joints, well knowing that he has the power of counteracting to a certain extent the ill effect of joints made by himself, but that those made by accident are irremediable.

The observations made in the section on brickwork, on the use of mortar, will apply here also. Of whatever quality the stone may be of which a wall is to be built, it should consist as much of stone and as little of mortar as possible. If the stone be inferior in durability and power of resisting the action of the atmosphere to the mortar, besides the certain fact that the mortar will yield until it has set hard, and so far act injuriously, no ulterior good is gained; and if the stone be the more durable material, the more of it that enters into the wall the better. Indeed, in rough walling, if the stones be pressed together until the more prominent angles on their faces come into actual contact, the interstices being occupied by mortar, it will be better than if a thick yielding mass were allowed to remain between them. Absolute contact, however, should not be permitted, any more than in brickwork, lest the shrinking of the mortar in drying leave the stones to such unequal bearing as the prominent parts alone would afford. Stone being generally of a less absorbent nature than brick, it is not a matter of so much importance that it be wetted before setting; nevertheless, adhesion on the part of the mortar is more certain and more complete, if the stones be worked in at least a damp state.

What bond is, and the necessity for it, have also been shown in the preceding section; and bond is of not less importance in stone walling than in bricklaying. We have also hinted above at the greater difficulty of understanding, forming, and preserving it in the former, and can now only add a few observations in addition that can be of any use, and these with reference to rubble walling particularly. Instead of carefully making the joints recur one over the other in alternate courses, as with bricks and gauged stones, the joints should as carefully be made to lock, so as to give the strength of two or three courses or layers between a joint in one course and one that may occur vertically over it in another. In bonding through a wall, or transversely, it is much better that many stones should reach two-thirds across alternately from the opposite sides than that there should be a few thorough stones, or stones extending the whole thickness of the wall. Indeed, one of the many faults of stone masons is that of making a wall consist of two scales or thin sides, with thorough stones now and then laid across to bind them together, the core being made up of mortar and small rubble merely. This is a mode of structure that should be carefully guarded against. There is no better test of a workman's tact and judgment in rubble walling than the building of a dry wall, or wall without mortar, affords. Walls are frequently built with mortar that without it would have fallen down under their own weight in a height of 6 feet, in consequence of their defective construction,—thus rendering it evident that they are only held together by the tenacity of the mortar, which is very seldom an equivalent for a proper bond of stone. Masons are very apt to set thin broad stones on their narrow edges to show a good face, by which the wall is injured in two ways; the practice tends to the formation of a mere case on the surface of a wall, and it for the most part exposes the bed of the stone to the atmosphere, as a stone is more likely to be broad in the direction of its bed than across it.

The footings of stone walls ought to consist of the largest stones which can be conveniently procured. It is better to have them of a rectangular form than any other; and if they are not square, their largest surfaces should be laid horizontally. With this shape and disposition they will make the greatest resistance to sinking. When footings can be obtained the full breadth of the wall in one piece, they are to be preferred; but if not, then every alternate stone in the course may be the whole breadth. Each course should be well bedded in mortar.

Rubble walling is either coursed or uncoursed. In the latter sort, fig. 5, Plate XXI., the work is carried on with stones of any sizes, as they occur, and without reference to their heights, somewhat in the manner of the Cyclopean walling of antiquity,—the interstices of the larger being filled up with smaller stones. For this work the mason uses no tool but the trowel to lay on the mortar, the scabling hammer to break off the most repulsive irregularities from the stones, and the plumb-rule to keep his work perpendicular. The line and level are equally unnecessary, as the work is independent of considerations

which are affected by them. An attentive and intelligent workman will, however, make a sound wall with this species of construction, by fitting the stones well together and packing them with as little mortar as possible, yet filling every crevice with it, and carefully bonding through to secure compactness, transversely at the least.

In coursed rubble walling, fig. 6, Plate XXI., the line and level are used, the work is laid in courses, each course being carefully brought up to the same level in itself, though no attention is paid to uniformity in the heights of the different courses. For this species of walling the stones are generally thoroughly dressed by the workman in the gross before he begins building. He is careful to get parallel beds to them, and he brings the best face of each stone to a tolerably even surface at right angles to the beds; the ends, too, receive some little attention, and for this purpose he uses an axe in addition to his scabling hammer. The quoins in coursed rubble walling are generally built with peculiar neatness and precision, and they are set to serve as gauge courses for the rest. This, when well executed, makes a sound and excellent wall. It presents, however, rather a rough and homely appearance, and in finer works must be covered with stucco or cement, or faced with ashlar.

Ashlar is an external rind of gauged stones in equal courses, having tooled or closely-fitting joints to give a wall a neat and uniform appearance; it is axed, tooled, or rubbed, as may be thought most in character with the structure, or that part of it to which it is to belong. Ashlar stones, or ashlars as they are commonly called, are made of various sizes on the surface, as the character of the edifice may require or convenience demand, and vary in thickness from 5 to 8 or 9 inches. Some of the ashlar stones must, it is clear, be used transversely as bond stones, or the facing, having nothing to connect it with the wall behind, would soon totter and fall. Bond stones are generally put in alternate courses, with the backing to the jambs of openings, such as windows, and oftener, if these do not recur within a length of 5 or 6 feet; the bond stones themselves, too, should not fall in the same vertical chain, except when they are in the jambs of openings, but should break in their alternate courses. Ashlar is commonly set in fine mortar or in putty. It is generally recommended that ashlars should not be made regular parallelopipeds, but run back irregularly to tooth in with the backing, the vertical joints being left open from about an inch within the face of the wall, and the upper surface or bed of the stones made narrower than, though perfectly parallel to, the lower. These things may exert a slightly beneficial influence under some circumstances; but the mode of construction involved is so radically bad, that unless the backing is set in a quick-setting cement, or is so well packed as to be proof against its general tendency to settle away from the ashlar facing, no method of the kind can materially improve it. A well-compacted wall of coursed rubble, the courses being frequently made up of whole stones and faced with ashlar, may be made tolerably sound and trustworthy. Brick backing, with ashlar facing, cannot be considered as good, though it has the advantage of not requiring battening and lathing for inside plastering, as the stone-backed wall does. Uncoursed rubble with ashlar has all the disadvantages of both the preceding, with nothing to recommend it before either of them. A thin inner brick wall, like a hollow wall, is very often necessary, where it is anticipated that the rain will be beaten through the stone-work by the impetuosity of the wind. The settlement of these two kinds of work during the setting of the mortar is so different, that the walls often separate; or where this is prevented by bond stones, the walls bulge outwards and bear unequally on their base. These evils are best prevented by using as little mortar as possible in the interior parts of the wall, and not raising the wall a great height at a time.

In order to give an uniform colour to a stone or ashlar wall, masons mix up pounded chippings of the stone they have used with some lime, salt, whiting, and size, and a little ochre, with which they colour the stone as they clean off the work. It is called badigeon, and is used also on plastered walls, where joints are sometimes drawn in colour to represent stone-work. Small defects in the stone are filled up with the same, or with shell-lac and the pounded stone.

There are many different sorts of walling or modes of structure arising from the nature of the materials furnished in various localities. That of most frequent occurrence, perhaps, is a manner in which either squared, broken, or rounded flints are used. These depend entirely on the care with which they are arranged, and on the mortar with which they are compacted, as also on a coursed chain, which is commonly introduced at short intervals of larger stones or of bricks, to act as a bond; the quoins, too, in this species of structure are generally constructed of dressed stones or of brick. Another sort of building is that of Pisé work, which from its economy as well as its general utility, has been much used in various countries. It consists of merely compressing earth in moulds or cases, whereby houses of two or three stories in height can be raised. Strong earths, with a mixture of small gravel, form the best material. The earth cannot be used when it is either too dry or too wet; when prepared it is put into the moulds and rammed down. The openings for the doors and windows must be left at the time of building the walls; and the openings have to be faced with wood for hanging the doors or for inserting the frames. The exterior decorations are best made of stone or brick; wood will not unite very well with the Pisé; the flues are also formed of brickwork. The exterior should be cemented or rough-casted, which should only be done when the wall is quite dry, or the cement will be cast off by the damp. The walls require to be bonded at the angles by thin rough planks to each course of about 3 feet in height, and the interior walls to be likewise so tied to the main ones. Such work has lasted over a century and a half. It was extensively practised at Lyons and in the south of France during the last century. Several attempts have been made of late years to build concrete walls for houses, and with much success. The process is similar to that already described. One patentee has been enabled to produce a cheap material wherewith he has built every part of a house,—walls, floors, staircase, and a flat roof, and even the doors, the material being set in an iron frame, thus rendering the house perfectly incombustible. Several such "monolithic doors" have lately been put up in London in place of plate iron doors.

Whatever objections lie against bond timber in brickwork apply with equal force at least to the use of it in stone walls. Hoop-iron bond is not only available in all kinds of stone walling, including the highly-wrought close-jointed kind, but it is invaluable, as it may be used both longitudinally and transversely as it may in brickwork; whilst it compels the building mason to bring his work up to a true and fair bed as often as the bond is to be laid in it. Discharging arches, it must be evident, are as necessary in and to stone walls as to walls of brick, and they may be treated much in the same manner. See fig. 10, Plate XX., and fig. 4, Plate XXI.

When walls are not entirely of masonry, in the ordinary course of economic building, stone is frequently used for copings, cornices, string and blocking courses, sills, landings, pavings, curbs, steps, stairs, hearth-stones and slabs, and chimney-pieces; to these may be added quoins and architectural decorations or dressings for windows, doors,

&c., though both the former and latter are not unfrequently executed in plaster composition or cements. Quoins. Quoin-stones are gauged and wrought blocks with parallel beds and vertical faces, placed on the angles of buildings in the Greek, Roman, and Italian styles, with the intention of adding to their beauty and strength, as in fig. 7, Plate XXI.; they are used in all kinds of walling, and are generally made to project before the face of that to which they are attached, mostly with a weathered angular joint, or with a rectangularly grooved or moulded one. The quoins are coursed with the rest of the wall if it be of stone, and are made to occupy the exact space of a limited number of courses of brick in a brick wall, or of flints where these are used. Copings. Copings in Italian work to cover walls, parapets, &c., are worked with a plain horizontal bed, two vertical faces, and an inclined or weathered back or upper surface,—either forming an acute angle with the outer and wider, and an obtuse angle with the inner and narrower face, to throw the water off, shown at *a* fig. 9, Plate XXI.; or sloping to both sides from the middle, as at *b*; the latter is technically termed saddle-back coping. In both cases they are made to project over the wall or parapet on both sides; and in the projected part of the bed under the edge or edges towards which the inclination is given, a channel or groove, called a throat, is cut, to intercept the water in its Throating. inclination to run inwards to the wall. On gables or other inclined planes the coping is neither weathered nor throated, as the water is necessarily impelled along its course to the lower end, and not over the sides. It is a curious circumstance that the mediæval designers rarely made their copings to project on the inside of a parapet, as shown in fig. 16, so that the exterior projection, which was returned up, was perhaps intended as much for effect as use. To protect the separate stones of a coping course from the danger of being displaced by high winds or other accidental causes, and to form a chain through its whole length, the stones are linked together Cramps. by cramps of copper or iron let into their backs and run with lead. These metals, however, especially the iron, for the most part act very injuriously, from their exceeding sensibility to atmospheric changes, and their greater or less tendency to oxidation; indeed, the stone invariably suffers more than the work Joggles, &c. benefits from the metal cramps. Tenons, dowels, joggles, or dovetails, of stone, of hard word, or of slate set in Portland cement, applied so as to be protected from the weather, are far better, and would answer every desirable purpose sufficiently. Lead dowels, when small, are occasionally used. The value of joggling and doweling to stone-work is well exemplified in the construction of Eddystone lighthouse. Cornices. Cornices are but ramified copings, and are or may be subjected to the same general laws. Care must be taken, however, in arranging them, that their centre of gravity be not brought too far forward, in the anxiety to project them sufficiently, lest they act injuriously on the wall by pressing unequally, and their own seat be also endangered. String course. String courses economically, in contradistinction to architecturally, are meant to protect a set-off in a wall, by projecting over its lower face in the manner of a coping, as in fig. 7, Plate XXI., at *c*; the beds are worked parallel, and the outer face vertical or at right angles to them, but so much of the upper surface is weathered or sloped off as protrudes from the upper part of the wall to carry the water off; and, for the reason above stated with regard to copings, the lower bed just within the outer face is throated. A stone string course, cramped or dovetailed in the bed, forms an excellent chain round a brick wall; but the part of it in the wall should be of the exact height of one, two, or more courses of brickwork. The woodcut, fig. 17, is a usual cornice or string course in the later period of mediæval art in England. Blo[cking] cou[rse]. A blocking course is either a very thick string projecting over or flush with the face of the lower part of the wall to cover a set-off; or it is a range of stone over a crowning cornice to bring the centre of gravity more in on the wall than it otherwise would be; in the former case it is treated exactly as a string, excepting that, if it be flush below, there is no occasion for a throat; in the latter it has a horizontal case bed, parallel vertical sides, and a weathered back or upper surface. Sill[s]. Sills are weathered and throated like the parts of a string course, Plate XXI., fig. 7, *a* and *b*; yet in mediæval work they may be seen flush with the upright of the wall. They are laid across window openings as a base to the sash-frame; distinct sills in the same line may, indeed, be considered as an intercepted string course. In the ordinary practice of building, window sills are seldom set in brick walls until they are absolutely required to set the sash-frames on; or they are set but not bedded, except at the ends. The object of this is to prevent any settlement that may occur in the piers from breaking the sills across on the unyielding part of the wall under the windows. A necessity for this, however, can only arise from bad construction; for with a good bond in the brickwork, all would settle together, and the sills might be completely bedded across at once.

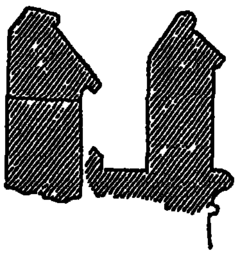


Fig. 16.—Copings.

Fig. 17.—Cornice.

Lan[dings]. Landings are platforms of stone, either over an area before a door, at the head of a flight of stairs, or as the floor of a balcony. They are made four, five, six, or eight inches in thickness, according to their extent and bearing; if not one piece of stone they are of nicely jointed pieces joggled and plugged together, and are worked on the face and edges just as their situation may demand. They should also be very carefully pinned into the walls. Fig. 18 will show the danger, should they not be so, through the full length of their insertion. If the front edge be pinned up, as at A, but a vacancy be left, as at B, the point C will become the fulcrum of a lever, and the landing have a tendency to turn at that point, and to break at the edge C. Every step and landing should have 8 inches hold in a brick wall. All landings should be well joggled; the joint joggles made as at *a*, fig. 19, is called by workmen a *he*, and that at *b* a *she* joggle. An accident at the Polytechnic Institution in London arose, no doubt, from the carelessness of the workmen, who put two landings together, in which two she-joggles were worked, as in fig. 20, and filled the open space with plaster. There happened to be a large fossil in the stone close to the wall in the landing *b*, which, having no support from the other landing *a*, gave way, and caused the destruction of the lower portion of the staircase upon which it fell.

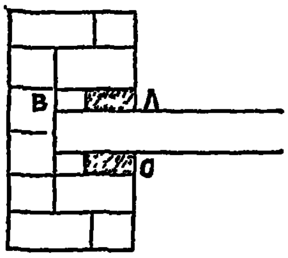


Fig. 18.—Extremity of Landing.

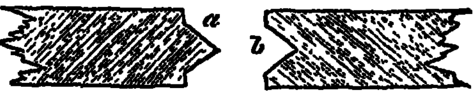


Fig. 19.—Joggles.

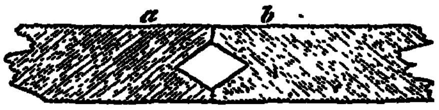


Fig. 20.—Joggles badly joined.

Stone pavings are prepared and laid in various ways. Ordinary paving is of self-faced or of tooled York; and for better purposes it is of rubbed Portland stone. For entrance halls, square stones, with the angles slightly cut off, the four spaces thus obtained being filled up by a small square of black or other coloured stone, makes a neat paving, which is replaced by marbles in best houses and public buildings, if a tesselated pavement be not required. Stone paving that is not exposed to the sun and air, if next the ground, should be laid on footings of brick or stone, or it will be constantly damp should the soil be close and clayey; but in yards, open areas, &c., it may be laid on the ground, bedded in sand, and jointed with mortar or cement. Stone-paved floors should be formed on brick arches, or on a timber floor prepared for the purpose; the latter, however, is a very bad mode of supporting paving, as the impression derived from the presence of the stone is, that the floor is incombustible; but if it be bedded on combustible material, the danger to human life in the event of fire is greater than if the stone paving did not exist at all. It is worked, cut, and set more or less expensively, according to circumstances. A curb is a range or course of thicker and stronger stone to bound a pavement, and is either flush with the paving showing as a step on its outer edge, or is raised above it to receive a balustrade, and shows on the outer side as a blocking course: in the latter situation it is generally joggled and plugged in the joints. The term step or steps alone is usually understood to mean external steps, whether arranged in long or short flights, or the single step in a doorway into which the door-frame is tenoned. A step should have a plain horizontal bed, and a very slightly weathered tread or upper surface,—the front or riser worked plain and vertical, or with a moulded nosing, and the back sunk with a joggle or bird's-mouth joint to receive the step or landing above or behind it. Steps for areas or back courts are often made of 2 or 2½ in. stone for the tread, the riser being formed of a 4½ or 5 in. stone, both tailed into a wall at one or both ends. This is much lighter in effect. Slate is sometimes used for the treads.

Stairs are but a flight or combination of steps used internally, and the general principle of designing staircases, as regards the rise and tread of steps, setting out curves, curtails, landings, &c., are given in the part treating of joinery. The chief difference between these and other staircases consists in the fixing, the one being framed with wooden strings, while the other have no strings, but are supported entirely by the walls. If there be a wall at each end, they are simply built in at the time the work goes up; but if they are supported at one end only, they are called geometrical stairs, and depend entirely on their being securely wedged into the wall; on which and on the support each derives at one edge from the step below, they wholly rely. If they are square in section, they are called solid steps; but as the under side or soffit, then, is irregular, it is usual to make the steps of somewhat a triangular shape, so as to present a continued soffit. In this case they are called arris, or feather-edge steps. Care should be taken that there are no sudden or irregular changes in the curves. These may be easily avoided by the method shown in the portion relating to joinery for the easing of the curves and ramps in handrails.

In houses built of stone the flues are usually formed in brickwork. The chimney-pieces consist of plain jambs, or boxings, or other vertical sides more or less decorated and moulded, and of the architrave or transverse covering or mantel, fig. 8, Plate XXI., with its shelf or cornice. The parts of a chimney-piece are generally put together with an adhesive plaster or cement, and affixed to the wall or chimney-breast behind with cramps, holdfasts, and plugs. The material of which chimney-pieces, if not of wood, are composed, varies from the coarsest stone to the finest marble; and the labour on them varies to a still greater extent.

Decorative masonry.

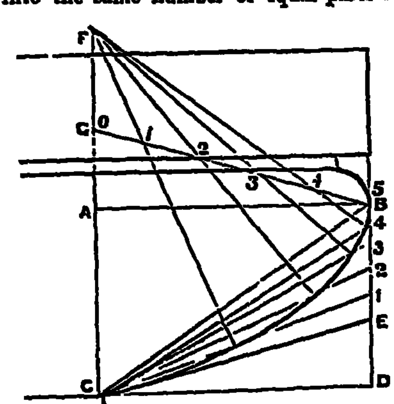
Masonry to receive architectural decorations is generally worked into the walls as they are carried up; but as they are seldom homogeneous either in matter or construction, the result is mostly the converse of what it purports to be, for the work is more frequently weakened than strengthened by the decorative masonry. Stones of which columns are to be composed, whether each column is to be of one stone or more, are generally roughly boasted out before they are set, and are finished afterwards to traversing moulds and templets with a plumb-rule, whose sides are cut to the diminution obtained from the bottom and upper diameters, whatever it may be. Flutes are cut at the same time and in the same manner. The beds of the joints in columns should be worked with the greatest precision, so as to obtain parallel planes, that they may fit firmly and closely together; they must not, however, be worked hollow to make a close joint externally, or the arrises will chip off. It is considered a good plan, where the columns are large, to put a piece of thin milled lead between the beds, cut circular, and extending to within a short distance of the surface, and that the rest be filled with a fine adhesive putty, made as nearly of the colour of the stone as possible. This makes a solid bed, and protects the arrises effectually; but it will not do so well for slight columns, because it narrows the bed so materially. A joggle or dowel of hard wood, slate, or cast-iron let into the core might be a sufficient counteraction, and it would certainly add to the stability of a polylithic shaft. The other parts of a columnar composition may be sufficiently cramped and joggled together with wood and metals according to the situation, though it may be again remarked, that neither wood nor metal should be used, unless it can be protected from access even of the atmosphere.

Columns.

Greek and Roman mouldings.

Sections for Roman mouldings are given in the part relating to joinery, but as those used in Grecian architecture are parts of conic sections, and not struck by compasses, we give a short problem by which they may all easily be set out. Both Roman and Grecian mouldings are shown on Plate XIII. of vol. ii.

Let an ovolo be the moulding required (fig. 21), the height of which (to the point where the moulding curves backward) is AC or BD, and the greatest projection AB or CD; and let CE be a tangent line, or line which the curve must touch but not cut. Produce CA to F, and make AF equal to AC, and AG to ED. Divide GB BE each into the same number of equal parts as 5. Draw the co-ordinates from F and C to the respective numbers, their intersections will trace the curve. If BE be more than half the whole height, the curve is an ellipse; if exactly half the height, it is a parabola; and if BE be less than half BD, the curve will be a hyperbola. All other mouldings can be drawn by this method, it being remembered that cymas, ogees, and all reflex curves, must be divided and drawn in two separate portions.



G. 21.—Construction of Ovolo.

Mediæval mouldings.

The mouldings in mediæval architecture differ entirely from those of other styles. They are chiefly formed by a combination of curves stopped by right lines or worked into other curves and hollows. The mouldings differ in

each of the several periods of the style in England, and also in the variations of the style as practised here and in each country on the Continent. We insert an outline, fig. 22, of a window jamb at Sleaford church, Lincolnshire, to show the forms and combination of an example during the Decorated period. A full description of those used in each style would exceed our limits, nor, indeed, is it a subject within the scope of this article. They are sometimes set out with the compasses, and many often appear to have been drawn by eye. We must refer our readers to the works of Professor Willis, F. A. Paley, and of J. H. Parker, for any details required about them. A very curious treatise was published by Professor Willis, called the *Architectural Nomenclature of the Middle Ages*, which goes at great length into the subject. A bead or astragal seems to have been called a bowtelle;

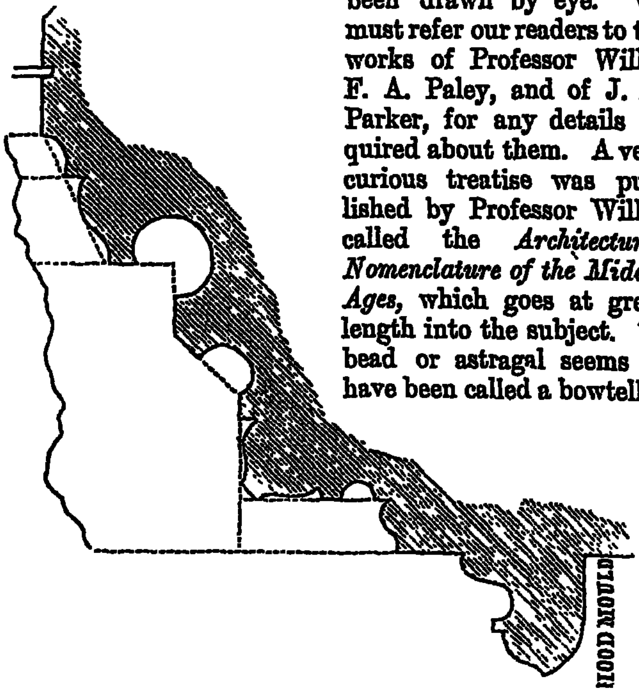


FIG. 22.—Outline of Window Jamb at Sleaford Church.

a torus, a grete bowtelle; a hollow or scotia, a casement; an ogee, a ressaunte, and so on.

Working the mouldings.

The methods of working mouldings in the stones at the builder's command have been already noticed at the commencement of this section. The soft stones and marbles are easily shaped into mouldings with the chisel and the mallet, and are sawn and the surfaces even finished with a plate having a fine edge. These stones will take mouldings of minuter character than the harder stones, which have to be worked with force, and require pointed tools to form the faces. The hardest material, granite, again, has to be stunned with heavy picks to make an impression, so that only bold ornaments have a good effect; much money has been thrown away in details more suitable for softer materials. Good effect is obtained by the contrast of axed and polished surfaces. A designer should visit the places where buildings in granite have been erected for a knowledge of a proper application of that material.

Arches.

The earliest arches were circular and, of course, easily set out. But as the Pointed styles came in, several methods were used for describing them. Pointed arches may be classed as—1st, lancet; 2d, equilateral; 3d, depressed;

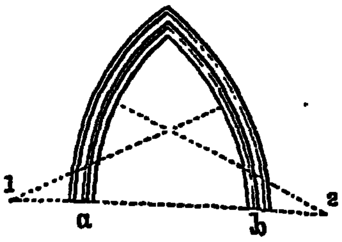


FIG. 23.—Lancet Arch.

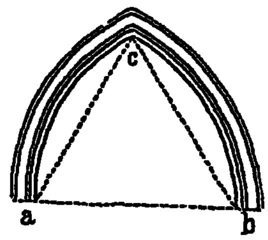


FIG. 24.—Equilateral Arch.

and 4th, four-centred or Tudor. In the first the centres, as 1, 2, in fig. 23, are outside the arch *a b*. At Westminster Abbey the arches of the choir are so acutely pointed that the distances 1*a* and 2*b* are nearly two-thirds of the entire opening *a b*. In the nave at York the points are without the arch at a distance of about one-fifth the opening *a b*. In equilateral arches the centres are exactly on the points *a b* in fig. 24, so that the apex *c*, joined to *a* and *b*, will form an equilateral triangle. The nave arches at Wells are of this description, and also those at Lincoln (see vol. ii. Plate XVIII. fig. 1). In later times the arches were of lower pitch, as fig. 25, and then, of course, the centres 1 and 2 were within the arch *a b*. At Salisbury Cathedral the distance *a*1 is one-sixth of *a b*, while in the choir at Lincoln (vol. ii., Plate XVIII., fig. 2) it is as much as two-fifths. To describe arches which shall be similar to one another throughout a building, however the openings may

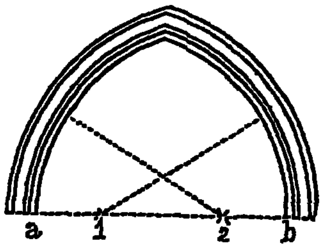


FIG. 25.—Depressed Arch.

differ, this principle must always be borne in mind, that the centres are to be always distant from the points *a b* by some aliquot portion of the whole opening. This is the more important, as the lines of tracery will not fall into their proper places except the arches are set out upon some regular principle. If the arches are not equilateral, some distance from each point *a b* should be first determined on (say one-third the opening *a b*), and after this, whatever the span of the other arches may be, one-third its own opening is to be taken from the points *a b*, as the centres from which to strike its curves. The only exception is that, in mediæval buildings, the arches to the doorways are frequently somewhat flatter than those of the windows. In the Tudor period the arches are very frequently drawn from four centres instead of two. As there has been great misapprehension as to four-centred arches, some persons treating them as parts of conic sections, whereas they are really parts of segments of circles, it is thought well to give two methods of describing these arches.

Four-centred

First, when the width AB, fig. 26, of the arch, and the apex height OC, are given, and a tangent to the upper circle as CD. In this case draw AD perpendicular to AB, and set out A1 equal to AD; draw C3 perpendicular to CD, and make CE equal to AD or A1; join 1E and bisect the same as shown by a perpendicular meeting CE produced in 3; join 3 1 and produce towards F, then 1 and

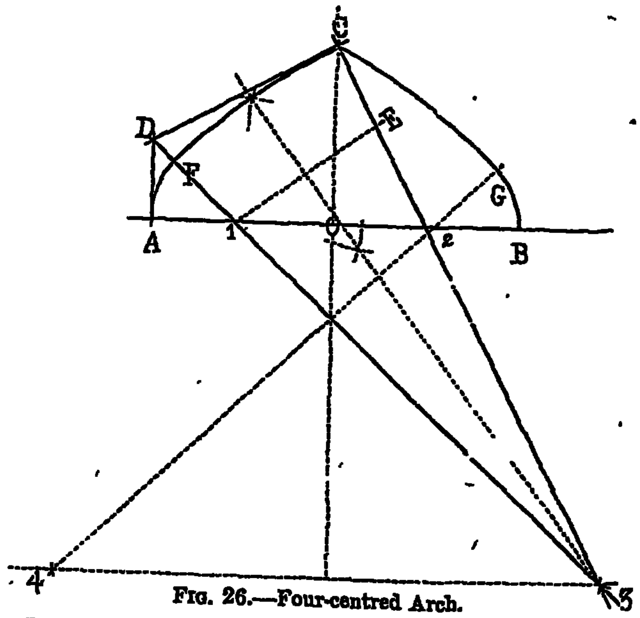


FIG. 26.—Four-centred Arch.

3 will be the centres for half the arch; and, transferring the points across, 2 and 4 will be the centres for the other half. In the second case, when the width AB and the height OC, and the centres of the small circles 1, 2, are given. Make AD equal to A1, join CD (which will be a tangent to the upper curve), draw C3 at right angles

thereto, make CE equal to AE, join BE, bisect the same, and proceed as before. The points FG, as has before been explained, are the points where the circles will meet each other. The joints to these arches will all radiate to their respective centres.

[Win]dow [trac]ery. Specimens of various sorts of the tracery which adorn the windows of the mediæval periods, and are in fact their greatest glory, are shown in Plates XVIII., XIX., and XX. of vol. ii. The designs for tracery are almost infinite, and the various methods of setting them out would fill a volume. But although they display such ingenuity and fancy that one would think the design to be quite arbitrary, it will be found that they are all, or very nearly all, set out on the principle of geometrical intersections. An example will show the principles on which the mediæval architects proceeded to describe the tracery, and also the method of finding the joints of the various pieces of stone.

Let $a\,b$ (fig. 27) be the opening of the arch; as there are to be two mullions, divide the same into three equal parts, as $a\,c$, $c\,d$, $d\,b$; then determine the points from which to strike the arch. In this instance, for the sake of simplicity, we make it equilateral (as in fig. 24); a and b then are the centres for striking the main

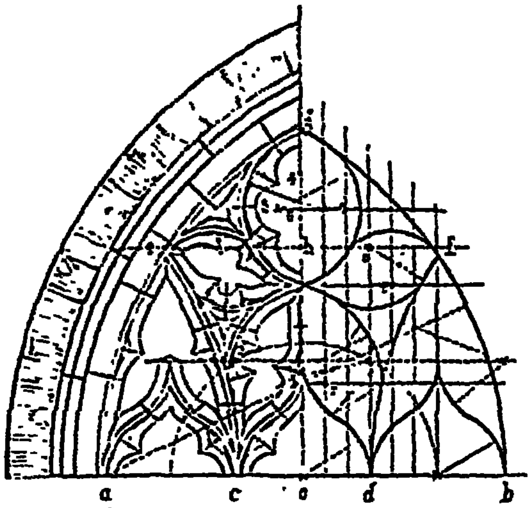


FIG. 27.—Construction of Window Tracery.

arch $a\,e\,g$, $b\,f\,g$, and the height $o\,g$ is that of an equilateral triangle. Produce the springing line, and the same opening of the compasses through c and d will give the principal inner branches of the tracery $e\,c$, $d\,f$. From the centre o, with an opening extending to the middle of the lights $a\,c$, $d\,b$, strike a semicircle; raise perpendiculars from d and c to 1 and 2; draw a line through 1 and 2; on this and the springing line will be found the centres of the lower ogees; bisect the part of $g\,o$ cut off by 1 2 in h, which is in fact the same thing as dividing the whole height $o\,g$ into three; divide $h\,g$ into three parts, at 3 and 4; through 3 draw a horizontal line, and set off from 3 distances one-third of the width $o\,d$, or draw the perpendicular lines as shown, which is better; then 5 and 6 will be the centres of the upper quatre-foil. From the line 1 2, on the same perpendicular as last, set down similar points, as at 7. These will be the centres for the lower subdivision as shown. Next draw $e\,h\,f$ and subdivide by similar perpendiculars, and where the lines intersect, as at 8, will be the centres for the upper subdivisions. The lines thus drawn will form a species of skeleton diagram, as shown on the right side of fig. 27, which is called the *element of the tracery*, and is in fact the centre line of the mullion, as shown by a, fig. 28. On each side of this, using always the same centres for the same branches, draw lines, showing the face (or what the workmen call the *nose*) of the mullion, and answering to $b\,c$; and then others answering to the sides of the mullion, as $d\,e$. Any other mouldings upon their sides or faces may be drawn in like manner. Put in the cusping as shown, and the tracery is complete. The practical stone-mason will take care never to make a joint where there is an angle of any sort, as the point of a cusp. In all cases the joints must tend to the centres of the circles from which they are struck, and where the lines branch off in two directions, the joints must not be in one line, but must tend in two, or as many directions as there are branches, and each to the centre of

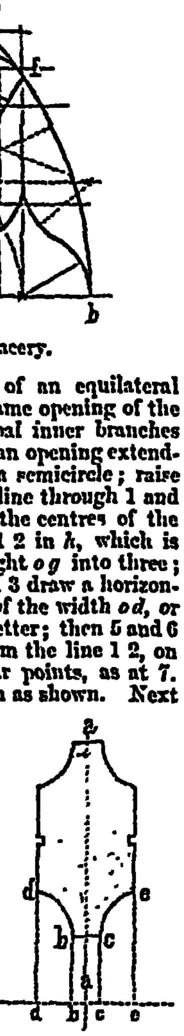


FIG. 28.—Mullion.

such respective branch. When the lines are perpendicular, as at c and d, and at the joint below h, the joints are horizontal. A close inspection of fig. 27, where they are carefully drawn, will fully elucidate the matter. The elaborate west window at York Cathedral (see Plate XVIII. of vol ii.) is entirely set out on this principle; and so is the still more remarkable instance, the eastern window at Carlisle, which is composed of 86 pieces of stone, and the design for which is drawn from 263 centres.

All the upper construction of windows and doors, and of aisle arches, should be protected from superincumbent pressure by strong relieving arches above the labels, as shown by the dark tints in fig. 27, which should be worked in with the ordinary masonry of the walls, and so set that the weight above should not press on the fair work, in which case the joints of the tracery, &c., will sometimes flush or break out.

In mediæval vaults the crowns $a\,b$, $c\,d$, are not level, but all have a slight curve or spring, as shown in fig. 29, and the filling-in between them also is slightly curved, so as to partake in some degree of the character of the dome as well as of the groined arch; and for the most part the ribs in early vaulting are not true segments of ellipses, but approximations drawn by the compasses. The triumph of mediæval stone-masonry, however, is that species of groin known as fan-vaulting. It is unlike that of any other age or time. The roofs of King's College Chapel at Cambridge and of Henry VII.'s Chapel at Westminster are eminent and late examples. The earliest are supposed to be in the cloisters of Gloucester Cathedral. It is impossible in our limited space to give demonstrations of them, and we must refer our readers to the admirable treatise on the subject by Professor Willis, published in the first volume of the *Transactions* of the Royal Institute of British Architects. The filling-in between the ribs of mediæval groins is generally of clunch, or of some soft stone, over which a layer of concrete is sometimes placed in such manner as to bind all together and to resist the thrust. Mediæ[val] vaultin[g].

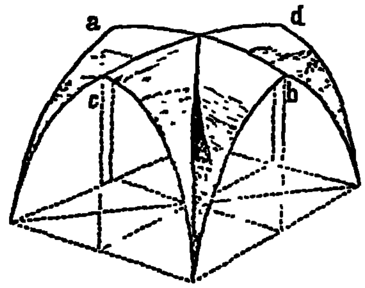


FIG. 29.—Mediæval Vaulting.

The bold and beautiful termination to mediæval towers, which we call a spire, and the French call *flèche*, is another proof of the skill of the mediæval masons. These are generally octagonal, and rise partly from the wall of the tower and partly from arches thrown angle-wise from wall to wall inside, to cut off the corners, as it were, and afford a springing to the spire. The wonder of these constructions is their extreme lightness and thinness. The top of the spire at Salisbury is 411 feet from the ground, of which the tower takes up 207 feet, leaving, of course, 204 feet for the height of the spire itself; this is only 9 inches thick at the bottom, diminishing to 7 inches, or on an average only about the 300th part of its height. It has been attempted to show mathematically that the joints of a spire would be stronger if formed at right angles to its face; but they would then slope inwards and hold the wet, which in sudden frosts would do most serious injury; practically, therefore, it is found best to lay the courses on a level bed. They should, however, be frequently doweled and cramped together, but not with metal, for the extreme thinness of the stone would soon cause it to rust and break out the stone. Spires.

The principal publications on masonry are as follows:—
English.—Moxon, *Mechanick Exercises*, 4to, 1677–93, 1700; Batty Langley, *Ancient Masonry*, fol., 1736; Nicholson, *Practical Builder*, 4to, 1823, &c.; *Practical Treatise on Masonry*, 8vo, 1828,

Guide to Railway Masonry, 8vo, 1839–46; and *Practical Masonry, Bricklaying*, &c., 4to, 1830; Dobson, *Rudimentary Treatise on Masonry*, 1849, 1856; Robson, *Masons', Bricklayers', and Decorators' Guide*, 4to, 1862.

Foreign.—De l'Orme, *Nouvelles inventions pour bien bastir*, &c., fol., 1561; Jousse de la Flèche, *Secrets d'Architecture*, fol., 1642; Bosse, *La Pratique du trait pour la Coupe des Pierres*, fol., 1643; Derrand, *Des Traits et Coupe des Voutes*, fol., 1643; De la Rue, *Traité de la Coupe des Pierres*, fol., 1728; Frézier, *Traité de Stéréotomie*, 4to, 1737; and *Eléments de Stéréotomie*, 1759; Simonin et Delagardette, *Traité de la Coupe des Pierres*, 4to, 1792; Douliot, *Traité speciale du Coupe des Pierres*, 4to, 1825; *Vorlegeblätter für Maurer*, fol., 1835; Adhémar, *Traité de la Coupe des Pierres*, fol., 1836–40; Normand, *Épures d'Escaliers en Pierre*, 4to, 1838; Le Roy, *Traité de Géometrie descriptive*, 4to, 1850; Claudel et Laroque, *Maçonnerie Pratique*, 8vo, no date; the article *Maçonnerie* in the various *Encyclopédies*; and the general treatise by Rondelet, *L'Art de bien bâtir*, with supplement by Blouet, fol., 1842–46.

Sawyer-work.

The labour of the sawyer is applied to the division of large pieces of timber or logs into forms and sizes to suit the purposes of the carpenter and joiner. His working-place is called a saw-pit, and his almost only important tool a pit-saw. A cross-cut saw, axes, dogs, files, compasses, lines, lamp-black, black-lead, chalk, and a rule, are all accessories which may be considered necessary to him.

The facility with which sawing whole timber is now done by the aid of the upright saw-frame, and smaller timber by the circular-saw bench, has in large factories and workshops caused the saw-pits to be out of date; timber after it has been cut at the mills can be again reduced into sizes and scantlings at a rapid rate, and with great exactitude and little labour. In some country parts, however, the saw-pit is still used. Unlike most other artificers, the sawyer can do absolutely nothing alone; sawyers are therefore always in pairs,—one of the two standing on the work, and the other in the pit under it. The log or baulk of timber being carefully and firmly fixed on the pit, and lined for the cuts which are to be made in it, the top-man standing on it, and the pit-man below or off from its end, a cut is commenced, the former holding the saw with his two hands by the handle above, and the other in the same manner by the box handle below. The attention of the top-man is directed to keeping the saw in the direction of and out of winding with the line to be cut upon, and that of the pit-man to cut down in a truly vertical line. The saw being correctly entered, very little more is required than steadiness of hand and eye in keeping it correctly on throughout the whole length. In the operations of the carpenter and joiner much depends on the manner in which the sawyers have performed their part. The best work on the part of the carpenter cannot retrieve the radical defects in his materials from bad sawing; and although the joiner need not allow his work to suffer, bad sawing causes him great loss of wood and immense additional and otherwise unnecessary labour. Planks or boards, and scantlings, on coming from the saw-pit, should be as straight and true in every particular, except mere smoothness of surface, as if they had been tried upon the joiner's bench; and good workmen actually produce them so. Saw-mills, too, by the truth and beauty with which they operate, show the sawyer what may be effected; for though he can hardly hope to equal their effect, he may seek to approach it.

Carpentry.

Carpentry or carpenter's work has been divided into three principal heads, namely, *descriptive*, *constructive*, and *mechanical*. The first shows the lines or methods for forming every species of work by the rules of geometry; the second comprises the practice of reducing the timber into particular forms, and joining the forms so produced so as to make a complete whole according to the intention or design; and the third displays the relative strength of the timbers and the strains to which they are subjected by their disposition. Here, we have merely to describe the practical details of carpenters' work in the operations of building. The carpenter works in wood, which he receives from the sawyer in beams, scantlings, and planks or boards, which he cuts and combines into bond-timbers, wall-plates, floors, and roofs. He is distinguished from the *joiner* by his operations being directed to the mere carcass of a building—to things which have reference to structure only. Almost everything the carpenter does in and to an edifice is absolutely necessary to its stability and efficiency, whereas the joiner does not begin his operations until the carcass is complete; and every article of joiners' work might at any time be removed from a building without undermining it or affecting its most important qualities. Certainly, in the practice of building, a few things do occur regarding which it is difficult to determine to whose immediate province they belong; but the distinction is sufficiently broad for general purposes. The carpenter, with the bricklayer or mason and some of the minor artificers, constructs the frame or hull; and the joiner, with the plasterer and others, decorates and rigs the vessel. On the former the actual existence of the ship depends, and on the latter depends her fitness for use.

The carpenter frames or combines separate pieces of timber by scarfing, notching, cogging, tenoning, pinning, and wedging. The tools he uses are the rule, the axe, the adze, the saw, the mallet, hammers, chisels, gouges, augers, wimbles, pincers, hook-pins, a square, a bevel, a pair of compasses, and a gauge, together with the level, square, and plumb-rule; besides these, planes (for making grooves, rebates, and mouldings), gimlets, pincers, a sledge-hammer, a maul or beetle, wedges, and a crow-bar may be considered useful auxiliaries, though they are not absolutely necessary to the performance of works of carpentry. Planing and other machines are used to diminish the great manual labour of working the surface of planks and boards, and of moulding, tenoning, and other similar operations; and so elaborate are some of these machines, that a four-panelled door can now be made complete in a couple of hours, which formerly was considered a good day's work for a man. Circular-saws are employed for working up larger timbers; and for ripping up boards or scantlings of moderate thickness, they are now used in all workshops. Tools.

The fir timber in general use is imported from Memel, Riga, Dantzig, and Sweden. Memel timber is the most convenient for size, Riga the best in quality, Dantzig the strongest, and Swedish the toughest. Riga timber can always be depended upon. Red pine may be used wherever durability and strength are objects; Quebec yellow pine for light dry purposes. In selecting timber, spongy heart, porous grain, and dead knots are to be avoided; the brightest in colour, and where the strong red grain appears to rise on the surface, are the best to be chosen. For joists and main timbers, the best woods are from Dantzig, Memel, or Riga; for partitions and minor timbers, American red wood, which not being so strong as the Baltic timber, must be cut to a little larger size. For sleepers, window-sills, and some parts of a roof, oak is used; for framing, Christiania deals or battens; for panelling, Christiania white deal or American yellow pine; for upper floors, Dram or Drammen and Christiania whites; for ground floors, Stockholm and Gefle yellows; for warehouse floors and staircases, Archangel and Onega planks; for best floors, St Petersburg, Onega, Dram, and Christiania battens. American deals Timber.

CARPENTRY

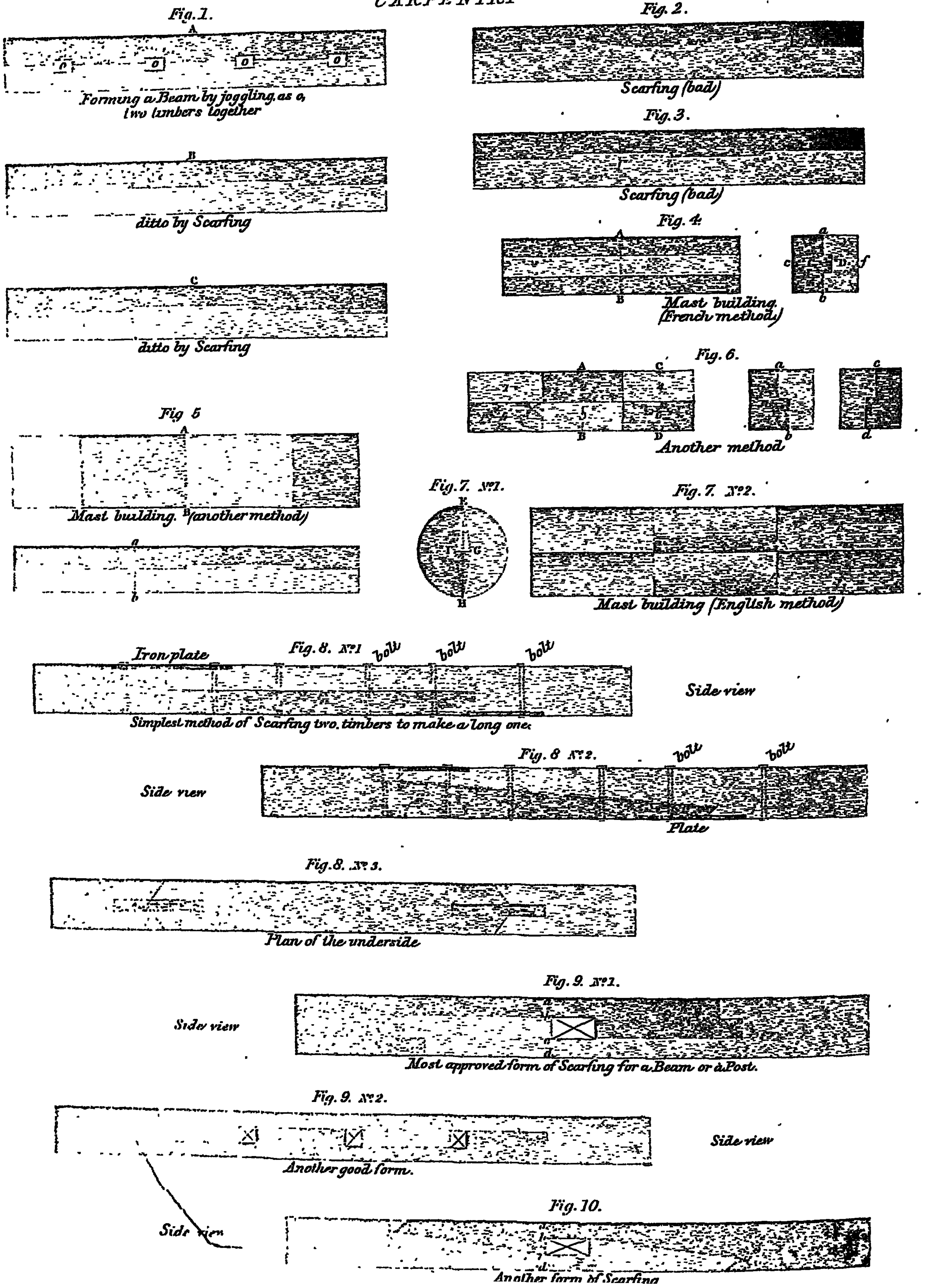


Fig. 1.
A
Forming a Beam by joggling, as o, two timbers together
B
ditto by Scarfing
C
ditto by Scarfing
Fig 5
A
B
Mast building. (another method)
a
b
Fig. 2.
Scarfing (bad)
Fig. 3.
Scarfing (bad)
Fig. 4.
A
B
a
c
D
f
b
Mast building. (French method)
Fig. 6.
A
C
B
D
a
b
c
d
Another method
Fig. 7. No.1.
E
F
G
H
Fig. 7. No.2.
Mast building (English method)
Fig. 8. No.1
Iron plate
bolt
bolt
bolt
Side view
Simplest method of Scarfing two timbers to make a long one.
Fig. 8 No.2.
bolt
bolt
Side view
Plate
Fig. 8. No.3.
Plan of the underside
Fig. 9. No.1.
Side view
a
b
c
d
Most approved form of Scarfing for a Beam or a Post.
Fig. 9. No.2.
Side view
Another good form.
Fig. 10.
Side view
d
Another form of Scarfing

should not be used for floors, as they are softer; and Swedish deals are bad for framing, as they warp. For interior finishings generally, Baltic red and white woods, and the American red and yellow pine, are to be preferred.

We must first proceed to consider the means by which form in the work of the carpenter is to be secured, and the connections by which the various strains are excited and communicated. The following practical remarks on various *joints* are abridged from the article by Prof. Robison in the former editions of this work.

The joinings practised in carpentry are almost infinitely various, and each has advantages which make it preferable in some circumstances. Many varieties are employed merely to please the eye. We do not concern ourselves with these; nor shall we consider those which are only employed in connecting small works, and can never appear on a great scale; yet even in some of these, the skill of the carpenter may be discovered by his choice; for in all cases it is wise to make every, even the smallest, part of his work as strong as the materials will admit. He will be particularly attentive to the changes which will necessarily happen by the shrinking of timber as it dries, will consider what dimensions of his framings will be affected by this and what will not, and will then dispose the pieces which are less essential to the strength of the whole in such a manner that their tendency to shrink shall be in the same direction with the shrinking of the whole framing. If he do otherwise, the seams will widen, and parts will be split asunder. He will dispose his boardings in such a manner as to contribute to the stiffness of the whole, avoiding at the same time the giving them positions which will produce lateral strains on truss beams which bear great pressures; recollecting, that although a single board has little force, yet many united have a great deal, and may frequently perform the office of very powerful struts.

Our limits confine us to the joinings which are most essential for connecting the parts of a single piece of a frame (when it cannot be formed of one beam, either for want of the necessary thickness or length), and the joints for connecting the different sides of a trussed frame.

Building up beams

Much ingenuity has been bestowed on the manner of building up a great beam of many thicknesses, and many singular methods are practised; but when we consider the manner in which the cohesion of the fibres performs its office, we see that the simplest are formed on the same principles as the most refined, and they are less apt to induce false notions of the strength of the assemblage. Thus, were it required to build up a beam for a great lever or a girder, so that it may act nearly as a beam of the same size of one log, it may either be done by plain joggling, as in Plate XXII. fig. 1, A, or by scarfing, as in B or C. If it is to act as a lever, having the gudgeon on the lower side at C, we believe that most artists will prefer the form B and C. We may frequently gain a considerable accession of strength by this building up of a beam, especially if the part which is stretched by the strain be of oak, and the other part be fir. Fir being so much superior to oak as a pillar, and oak so much preferable as a tie, this construction seems to unite both advantages. But much better methods of making powerful levers, girders, &c., are obtained by trussing. Observe that the efficacy of both methods depends entirely on the difficulty of causing the piece between the cross joints to slide along the timber to which it adheres. Therefore, if this be moderate, it is wrong to make the notches deep; for as soon as they are so deep that their ends have a force sufficient to push the slice along the line of junction, nothing is gained by making them deeper; and this requires a greater expenditure of timber.

Scarfings of beams are frequently made oblique, as in Plate XXII. fig. 2; but this seems a bad practice. It begins to yield at a point where the wood is crippled and splintered off, or at least bruised out a little. As the pressure increases, this part, by squeezing broader, causes the solid parts to rise a little upwards, and gives them some tendency, not only to push their antagonists along the base, but even to tear them up a little. For similar reasons we disapprove of the favourite practice of many artists to make the angles of their scarfings acute, as in fig. 3. This often causes the two pieces to tear each other up. The abutments should always be perpendicular to the directions of the pressures. This law is also to be extended to the abutments of different pieces of a frame, and the artist must even attend to the shrinking of the timbers by drying. When two timbers abut obliquely, the joint should be most full at the obtuse angle of the end; because, by drying, that angle grows more obtuse, and the beam would then be in danger of splintering off at the acute angle.

Wedging

It is evident that the nicest work is indispensably necessary in building up a beam. The parts must abut on each other completely, and the smallest play or void takes away the whole efficacy. It is usual to give the abutting joints a small taper to one side of the beam, so that they may require moderate blows of a maul to force them in, and the joints may be perfectly close when the external surfaces are even on each side of the beam. But we must not exceed in the least degree, for a very taper wedge has great force; and if the pieces be driven together by very heavy blows, the whole is left in a state of violent strain, and the abutments are perhaps ready to splinter off by a small addition of pressure. It is not unusual to leave some abutments open enough to admit a thin wedge reaching through the beam. Nor is this a bad practice, if the wedge is of material which is not compressed by the driving or the strain of service. Iron would be preferable for this purpose, and for the joggles, were it not that, by its too great hardness, it cripples the fibres of timber to some distance. In consequence of this it often happens, that in beams which are subjected to desultory and sudden strains (as in the levers of reciprocating engines), the joggles or wedges widen the holes, and work themselves loose; therefore skilful engineers never admit them, and indeed admit as few bolts as possible, for the same reason; but when resisting a steady or dead pull, they are not so improper, and are frequently used.

Beams are built up, not only to increase their dimensions in the direction of the strain (which we have hitherto called their depth), but also to increase their breadth, or the dimensions perpendicular to the strain. Sometimes the breadth of girder is doubled, if it is thought too weak for its load, and when the thickness of the flooring must not be increased.

Masts and uprights

The mast of a great ship of war must be made bigger athwartship, as well as fore and aft. This is one of the nicest problems of the art; and professional men are by no means agreed in their opinions in regard to it. We shall content ourselves here with exhibiting the different methods. The most obvious and natural method is that shown in Plate XXII. fig. 4. It is plain that (independent of the connection of cross bolts, which are used in them all when the beams are square) the piece C cannot bend in the direction of the plane of the figure without bending the piece D along with it. This method is much used in the French navy; but it is undoubtedly imperfect. Fig. 5 exhibits another method. The two halves of the beam are tabled into each other in the same manner as in fig. 1. It is plain that this will not be affected by any unequal swelling or shrinking, because this is insensible in the direction of the fibres; but when bent in the direction $a\,b$, the beam fig. 4 is weaker than bent in the direction

c f. Each half of fig. 4 has, in every part of its length, a thickness greater than half the thickness of the beam. It is the contrary in the alternate portions of the halves of fig. 5. When one of them is bent in the direction AB, it is plain that it drags the other with it by means of the cross butments of its tables, and there can be no longitudinal sliding. But unless the work is accurately executed, and each hollow completely filled up by the table of the other piece, there will be a lateral slide along the cross joints sufficient to compensate for the curvature; and this will hinder the one from compressing or stretching the other in conformity to this curvature.

The imperfection of this method is so obvious that it has seldom been practised; but it has been combined with the other, as is represented in fig. 6, where the beams are divided along the middle, and the tables in each half are alternate, and alternate also with the tables of the other half. Thus 1, 3, 4 are prominent, and 5, 2, 6 are depressed. This construction evidently puts a stop to both slides, and obliges every part of both pieces to move together. *a b* and *c d* show sections of the built-up beam corresponding to AB and CD. No more is intended in this practice by any intelligent artist, than the causing the two pieces to act together in all their parts, although the strains may be unequally distributed on them. Thus, in a built-up girder, the binding joists are frequently mortised into very different parts of the two sides. But many seem to aim at making the beam stronger than if it were of one piece; and this inconsiderate project has given rise to many whimsical modes of tabling and scarfing.

The practice in the British dockyards is somewhat different from any of these methods. The pieces are tabled as in fig. 6, but the tables are not thin parallelopipeds, but thin prisms. The two outward joints or visible seams are straight lines, and the table 1 rises gradually to its greatest thickness in the axis. In like manner, the hollow 5, for receiving the opposite table, sinks gradually from the edge to its greatest depth in the axis. Plate XXII., fig. 7, No. 1, represents a section of a round piece of timber built up in this way, where the full line EF, GH is the section corresponding to AB of fig. 6, and the dotted line EG, FH is the section corresponding to CD. This construction, by making the external seam straight, leaves no lodgment for water, and looks much fairer to the eye; but it appears to us that it does not give so firm a hold when the mast is bent in the direction EH. The exterior parts are most stretched and most compressed by this bending; but there is hardly any abutment in the exterior parts of these tables. In the very axis, where the abutment is the firmest, there is little or no difference of extension and compression. But this construction has an advantage, which, we imagine, much more than compensates for these imperfections, at least in the case of a round mast; it will draw together by hooping incomparably better than any of the others.

Joggles of elm are sometimes used in the middle of the large tables of masts; and when sunk into the firm wood near the surface, they must contribute much to the strength. But it is very necessary to employ wood not much harder than the pine, otherwise it will soon enlarge its bed and become loose, for the timber of these large trunks is very soft.

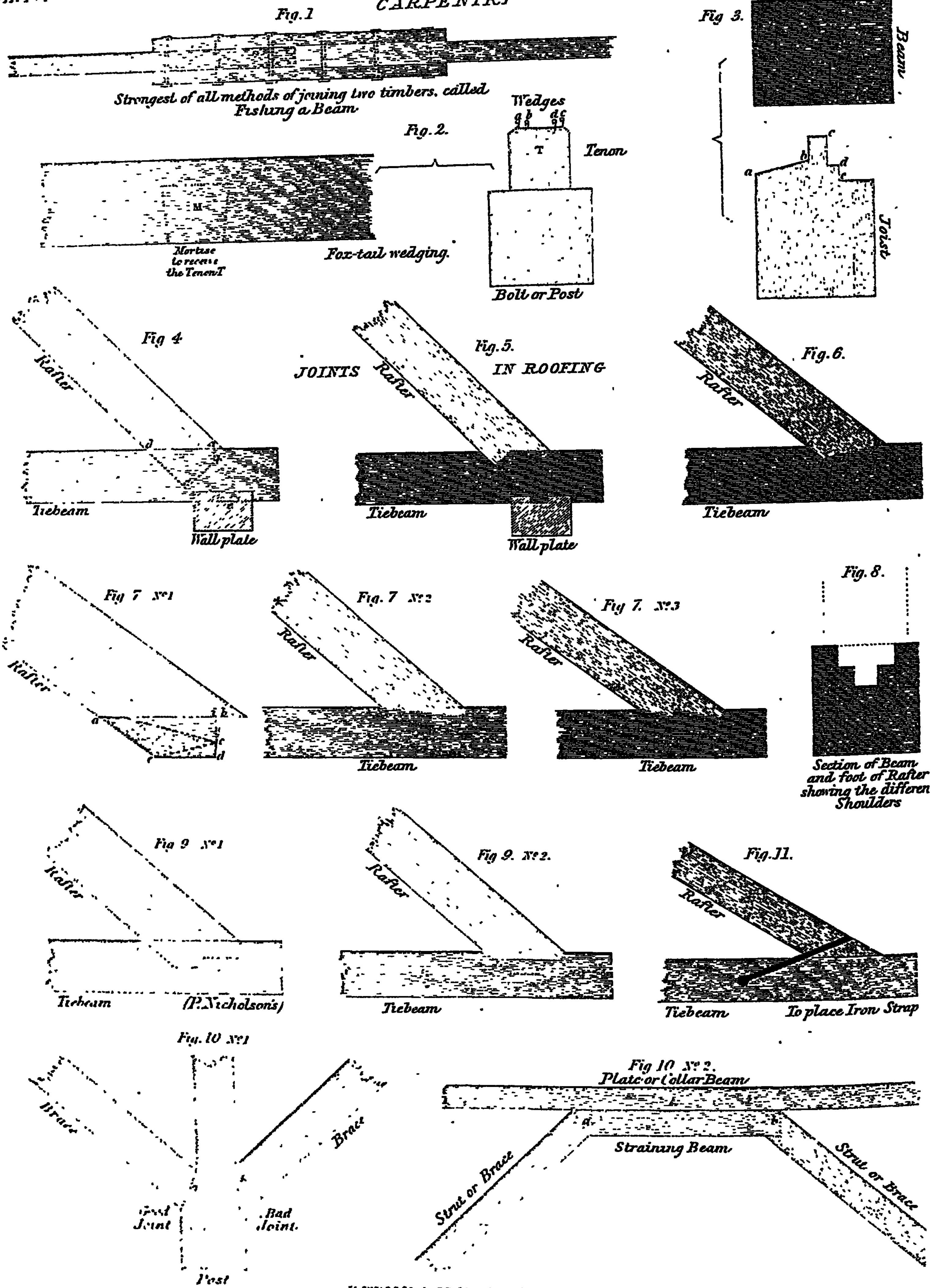
Scarfing. The most general reason for piecing a beam is to increase its length. This is frequently necessary, in order to procure tie-beams for very wide roofs. Two pieces must be scarfed together. Numberless are the modes of doing this, and almost every master carpenter has his favourite nostrum. Some of them are very ingenious; but here, as in other cases, the most simple are commonly the strongest. We do not imagine that any, the most ingenious, is equally strong with a tie consisting of two pieces of the same scantling laid over each other for a certain length, and firmly bolted together. We acknowledge that this will appear an artless and clumsy tie-beam, but it will be stronger than any that is more artificially made up of the same thickness of timber. The next simplest and most obvious scarfing is that represented in Plate XXII., fig. 8, Nos. 1 and 2. If considered merely as two pieces of wood joined, it is plain that, as a tie, it has but half the strength of an entire piece, supposing that the bolts (which are the only connections) are fast in their holes. No. 2 requires a bolt in the middle of the scarf to give it that strength, and in every other part is weaker on one side or the other. If the bolts were sufficiently numerous and sufficiently firm, so as to produce a great degree of adhesion or of friction between the parts, this joint might be made almost as strong as the entire beam, since there is nothing to prevent the co-operation of each side with the other throughout its extent; but much of the strength would be lost if the bolts became loose, even in an inconsiderable degree. But the bolts are very apt to bend by the violent strain, and require to be strengthened by uniting their ends by iron plates,—in which case it is no longer a wooden tie. The form of No. 1 is better adapted to the office of a pillar than No. 2, especially if its ends be formed in the manner shown in the elevation No. 3. By the sally given to the ends, the scarf resists an effort to bend it in that direction. Besides, the form of No. 2 is unsuitable for a post, because the pieces by sliding on each other by the pressure are apt to splinter off the tongue which confines their extremity. Figs. 9 and 10 exhibit the most approved form of a scarf, whether for a tie or for a post. The key represented in the middle is not essentially necessary; the two pieces might simply meet square there. This form, without a key, needs no bolts (although they strengthen it greatly), but, if worked very true and close, and with square abutments, will hold together, and will resist bending in any direction. But the key is a very great improvement, and will force the parts together with perfect tightness, but it must not be over driven. The form of fig. 9 is by far the best (it is sometimes said to be tabulated, that is, to render the joints as close as possible, and the juncture more independent of any bolts which might be placed similarly to those in fig. 8, No. 1),—because the triangle of fig. 10 is much more readily splintered off by the strain or by the key than the square wood of fig. 9. It is far preferable for a post, for the reason given in speaking of fig. 8, No. 1 and No. 2. Both may be formed with a sally at the ends equal to the breadth of the key. In this shape fig. 9 is well suited for joining the parts of the long corner posts of spires and other wooden towers. Fig. 9, No. 2 differs from No. 1 only by having three keys; the principle and the longitudinal strength are the same. The long scarf of No. 2, tightened by the three keys, enables it to resist bending much better.

None of these scarfed tie-beams can have more than one third of the strength of an entire piece, unless with the assistance of iron plates; for if the key be made thinner than one-third, it has less than one-third of the fibres to pull by. We are confident, therefore, that when the heads of the bolts are connected by plates, the simple form of fig. 8, No. 1, is stronger than those more ingenious scarfings. It may be strengthened against lateral bending by a little tongue, or by a sally, but cannot have both.

Fishing a beam. The strongest of all methods of piecing a tie-beam would be to set the parts end to end, and grasp them between other pieces on each side, as in Plate XXIII., fig. 1. This the ship-carpenter calls fishing a beam; it is a frequent practice for occasional repairs. Perronet used it for the tie-beams or stretchers by which he connected the opposite feet of

BUILDING

CARPENTRY



a centre, which was yielding to its load, and had pushed aside one of the piers above 4 inches

Where the beams stand square with each other, and the strains are square with the beams and in the plane of the frame, the mortise and tenon is the most perfect junction. A pin is generally put through both in order to keep the pieces united, in opposition to any force which tends to part them. Every carpenter knows how to bore the hole for this pin, so that it shall draw the tenon tight into the mortise, and cause the shoulder to butt close, and make neat work; and he knows the risk of tearing out the bit of the tenon beyond the pin, if he draw it too much. We may just observe, that square holes and pins are much preferable to round ones for this purpose, bringing more of the wood into action, with less tendency to split it.

Ship-carpenters have an ingenious method of making long wooden bolts, not passing completely through, which take a very fast hold, though not nicely fitted to their holes, which they must not be, lest they should be crippled in driving. They call it fox-tail wedging. They stick into the point of the bolt T, Plate XXIII., fig 2, thin wedges of hard wood, so as to project a proper distance; when these reach the bottom of the hole by driving the bolt, they split the end of it, and squeeze it hard to the side. This may be practised with advantage in carpentry. If the ends of the mortise are widened inwards, and a thin wedge be put into the end of the tenon, it will have the same effect, and make the joint equal to a dove-tail; but this risks the splitting the piece beyond the shoulder of the tenon, which would be unsightly, and may be avoided by two *very* thin wedges *a* and *c* being struck in near its angles, projecting equally; at a very small distance within these are to be placed two shorter ones *b*, *d*, and more within these if necessary. In driving this tenon, the wedges *a* and *c* will take first, and split off a thin slice, which will easily bend without breaking. The wedges *b*, *d* will act next, and have a similar effect, and the others in succession. The thickness of all the wedges taken together must be equal to the enlargement of the mortise towards the bottom.

When the strain is transverse to the plane of the two beams, great care must be taken by the artist in placing his mortise A mortise in a girder for receiving the tenon of a binding-joist of a floor should be as near the upper side as possible, because the girder becomes concave on that side by the strain. But as this exposes the tenon of the binding-joist to the risk of being torn off, we are obliged to mortise further down. The form in Plate XXIII., fig. 3, generally given to this joint is extremely judicious. The sloping part *a b* gives a very firm support to the additional bearing *e d*, without much weakening of the girder. This form should be copied in every case where the strain has a similar direction

The joint that most of all demands the careful attention of the artist is that which connects the ends of beams, one of which pushes the other very obliquely, putting it into a state of extension. The most familiar instance of this is the foot of a rafter pressing on the tie-beam, and thereby *drawing* it away from the other wall. When the direction is very oblique (in which case the extending strain is the greatest), it is difficult to give the foot of the rafter such a hold of the tie-beam as to bring many of its fibres into the proper action. There would be little difficulty if we could allow the end of the tie-beam to project to a small distance beyond the foot of the rafter; but, indeed, the dimensions which are given to tie-beams for other reasons are always sufficient to give enough of abutment when judiciously employed. Unfortunately, this joint is very liable to fail from the effects of the weather. It is much exposed, and frequently perishes by rot, or becomes so soft and friable that a very small force is sufficient either for pulling the filaments out of the tie-beam, or for crushing them together. We are therefore obliged to secure it with particular attention, and to avail ourselves of every circumstance of construction.

One is naturally disposed to give the rafter a deep hold by a long tenon, but it has been frequently observed in old roofs that such tenons break off. Frequently they are observed to tear up the wood that is above them, and push their way through the end of the tie-beam. This in all probability arises from the first sagging of the roof, by the compression of the rafters and of the head of the king-post. The head of the rafter descends, and the angle with the tie-beam is diminished by the rafter revolving round its step in the tie-beam. By this motion the heel or inner angle of the rafter becomes a fulcrum to a very long and powerful lever much loaded. The tenon is the other arm, very short; and being still fresh, it is therefore very powerful. It therefore forces up the wood that is above it, tearing it out from between the cheeks of the mortise, and then pushes it along. Carpenters have therefore given up long tenons, and give to the toe of the tenon a shape which abuts firmly, in the direction of the thrust, on the solid bottom of the mortise, which is well supported on the under side by the wall-plate. This form, represented in Plate XXIII., fig. 4, has no tendency to tear up the end of the mortise. The tenon has a small portion *a b* cut perpendicular to the surface of the tie-beam, and the rest *b c* is perpendicular to the rafter.

But if the tenon is not sufficiently strong and it is not so strong as the rafter, which is thought not to be stronger than is necessary), it will be crushed, and then the rafter will slide out along the surface of the beam. It is therefore necessary to call in the assistance of the whole rafter. It is in this distribution of the strain among the various abutting parts that the varieties of joints and their merits chiefly consist. We can only mention a few here that have met with most general approval.

The aim in fig. 5, Plate XXIII., is to make the abutments exactly perpendicular to the thrusts. The action is the same as against the joggle on the head or foot of a king-post. This is a very effectual joint; it is not, however, much practised. It is said that the sloping seam at the shoulder lodges water; but the great on seems to be a secret notion that it weakens the tie- eam. Fig. 6 exhibits a form that is more general, but certainly worse. The shoulder-joint is sometimes formed like the dotted line *abcdcfg* of fig. 6. This is much more agreeable to the true principle, and would be a very perfect method, were it not that the intervals *b d* and *d f* are so short that the little wooden triangles *b e d*, *d c f* will be easily pushed off their bases *b d*, *d f*. Fig. 7, No. 1, seems to have the most general approbation, but we fail to perceive its peculiar merits. It is the joint recommended by Price, and copied into books of carpentry as the *true joint* for a rafter foot. The visible shoulder-joint is flush with the upper surface of the tie-beam. The angle of the tenon at the tie nearly bisects the obtuse angle formed by the rafter and the beam, and is therefore somewhat oblique to the thrust. The inner shoulder *a c* is nearly perpendicular to *b d*. The lower angle of the tenon is cut off horizontally as at *e d*. Fig. 8 is a section of the beam and rafter foot, showing the different shoulders. Fig. 7, No. 2, is a simpler, and in our opinion a preferable joint. We observe it practised by the most eminent carpenters for all oblique thrusts; but it surely employs less of the cohesion of the tie-beam than might be used without weakening it, at least when it is supported on the other side by the wall-plate. Fig. 7, No. 3, is also much practised by the best carpenters. Fig. 9, No. 1, is proposed by Mr Nicholson as preferable to fig. 7. No. 3,

Various forms of joints.

:cause the abutment of the inner part is better supported. his is certainly the case, but it supposes the whole rafter go to the bottom of the socket, and the beam to be iicker than the rafter. Some may think that this will eaken the beam too much, when it is no broader than the fter is thick; in which case they think that it requires deeper socket than Nicholson has given it. Perhaps the lvantages of Nicholson's construction may be had by a int like fig. 9, No. 2.

Whatever is the form of these butting joints, great care ould be taken that all parts bear alike; and the artist ill attend to the magnitude of the different surfaces. In e general compression the greater surfaces will be less mpressed, and the smaller will therefore change most. hen all has settled, every part should be equally close. :cause great logs are moved with difficulty, it is very oublesome to try the joint frequently to see how the rts fit; therefore we must expect less accuracy in the terior parts. This should make us prefer those joints iose efficacy depends chiefly on the visible joint. It pears from all that has been said on this subject, that a ry small part of the cohesion of the tie-beam is sufficient r withstanding the horizontal thrust of a roof, even ough very low pitched. If, therefore, no other use is ade of the tie-beam, one much slenderer may be used, id blocks may be firmly fixed to the ends, on which the fters might abut, as they do on the joggles on the head id foot of a king-post. A tie-beam may have to carry floor or ceiling (sometimes the workshops and store-rooms a theatre), and therefore requires a great scantling, but equently beams have little to do, and contain an unneces- ry quantity of timber. It is therefore of importance to certain the most perfect manner of executing such a nt, and we have directed the attention to the principles at are really concerned in the effect. In all hazardous ses the carpenter calls in the assistance of iron straps; d they are frequently necessary, even in roofs, not- thstanding this superabundant strength of the tie-beam. it this is generally owing to bad construction of the ooden joint, or to the failure of it by time.

There needs but little to be said of the joints at a joggle orked out of solid timber; they are not near so diffi- lt as the last. When the size of a log will allow the ggle to receive the whole breadth of the abutting brace, ought certainly to be made with a square shoulder; , which is still better, an arch of a circle having the other d of the brace for its centre. Indeed, this in general ll not sensibly differ from a straight line perpendicular the brace. By this circular form the settling of the of makes no change in the abutment; but when ere is not sufficient stuff for this, we must avoid vel joints at the shoulders, because these always tend to ake the brace slide off. The brace in Plate XXIII., ;. 10, No. 1, must not be joined as at b, but as at a, or some equivalent manner.

When the very oblique action of one side of a frame of rpentry does not extend, but compresses, the piece on hich it abuts, there is no difficulty in the joint. Indeed joining is unnecessary, and it is enough that the pieces but on each other; and we have only to take care that he mutual pressure be equally borne by all the parts, and hat it do not produce lateral pressures, which may cause ne of the pieces to slide on the butting joint. A very light mortise and tenon is sufficient at the joggle of a ing-post with a rafter or straining beam. It is best, in eneral, to make the butting plain, bisecting the angle ormed by the sides, or else perpendicular to one of the ieces. In fig. 10, No. 2, where the straining beam a b annot slip away from the pressure, the joint a is preferable o b, or indeed to any uneven joint, which never fails to produce very unequal pressures on the different parts, by which some are crippled, others are splintered off, &c.

When it is necessary to employ iron straps for strength- ening a joint, considerable attention is necessary that we may place them properly. The first thing to be determined is the direction of the strain. This must be resolved into a strain parallel to each piece, and another perpendicular to it; and then the strap which is to be made fast to any of the pieces must be so fixed that it shall resist in the direc- tion parallel to the piece. Frequently this cannot be done; but we must come as near to it as we can. We can hardly give any general rules. Fig. 30 shows the nature of the strap or stirrup by which the king-post carries the tie-beam. The strap that we observe most generally ill placed is that which connects the foot of the rafter with the beam. It only binds down the rafter, and does not act against its horizontal thrust. It should be placed farther back on the beam, with a bolt through it, which will allow it to turn round. It should embrace the rafter almost horizontally near the foot, and should be notched square with the back of the rafter. It is represented in fig. 11, Plate XXIII. By moving round the eye-bolt, it follows the rafter, and cannot pinch and cripple it, which it always does in its ordinary form. We are of opinion that straps which have eye-bolts in the very angles, and allow all motion round them, are of all the most perfect. A branched strap, such as may at once bind the king-post and the two braces which butt on its foot, will be more serviceable if it have a joint. When a roof warps, those branched straps fre- quently break the tenons, by affording a fulcrum in one of their bolts. An attentive and judicious artist will consider how the beams will act on such occasions, and will avoid giving rise to these great strains by levers. In the fore- going reasoning upon the direction of straps, regard has been had especially to the economizing of their immediate strength; but it may happen that the principal purpose of the strap will be answered by its pressing the rafter firmly upon the beam, and this effect may be produced by a certain deviation from the horizontal position, with but little diminution of the strength of the strap,—a deviation which has also the advantage of allowing the strap to embrace the whole of the beam, without weakening it by driving a bolt through it. We must not, however, run the risk of crippling the end of the beam. A skilful carpenter never employs many straps, considering them as auxiliaries foreign to his art, and subject to imperfections in workmanship which he cannot discern or amend. We must refer the reader to Nicholson's *Carpenter and Joiner's Assistant* for a more particular account of the various forms of stirrups, screwed rods, and other iron-work, for carrying tie-beams, &c.

Placing straps.

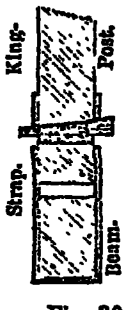
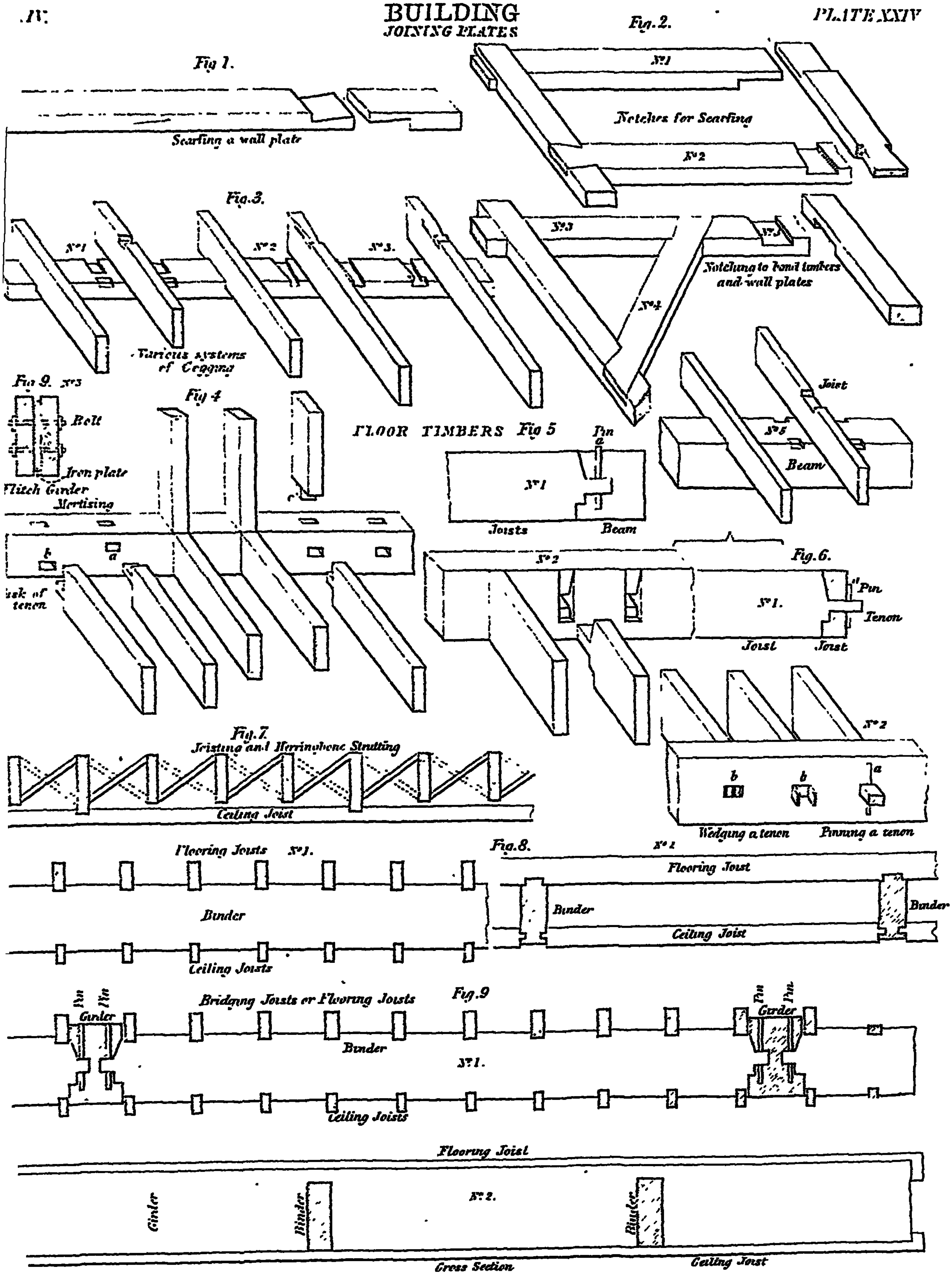


Fig. 30.

The diagrams of Plate XXIV. will illustrate the use of the before-described joints on a smaller scale in the further operations of the carpenter's work.

Ordinary scarfing is the cutting away equally from the ends, but on the opposite sides, of two pieces of timber, for the purpose of tying or connecting them lengthwise, and is done to wall-plates and bond-timber. The usual mode is by cutting about three-fifths through each piece on the upper face of the one and the under face of the other, about 6 or 8 inches from the end, as in fig. 1, Plate XXIV., transversely, making what is technically termed a *calf* or *kerf*, and longitu- dinally from the end, from two-fifths down on the same side, so that the pieces lap together with a sort of half dovetail. The heavy supervening weight of the wall and joists renders it impossible that they should be drawn apart without tear- ing the fibres asunder or lifting the weight. Nevertheless

JOINING PLATES



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hese joints are generally spiked, and it is always required that they be made to fall in or under a pier. Notching is either square or dovetailed; it is used in connecting the ends of wall-plates and bond-timber at the angles, in letting joists down on beams or binders, purlines on principal rafters, &c. Nos. 1, 2, 3, 4, and 5, fig. 2, show varieties of notches applied as we have described No. 1 is a simple square notch; No. 2, a dovetailed notch. No. 3 is the notch most commonly used; it is similar to No. 1, but that the ends are allowed to run on so that the one piece grasps the other, and each forms a cog to the other. No. 4 is an oblique-angled, dovetailed notch; and No. 5 shows how joists are notched or let down on beams and binders, and purlines on principal rafters. A notch is cut into the under edge of the joist or purline an inch or an inch and a half in depth, and considerably shorter than the beam, binder, or rafter is in thickness. Notches are also cut down on the upper angles of the bearing pieces, as long as the rider is thick, as deep as the notch before described of the latter is, and so far in as to leave a thickness on its own edge equal to the length of the notch in the riding joist or purline. In the diagram one joist is indicated in its place let down in the notch, and another indicates the notch in its own edge, and leaves exposed the notches in the binder. Cogging, or corking, as it is vulgarly termed, is the last-mentioned species of notch extended on one side, and leaving a narrow tooth or cog alone in the bearing-piece flush with its upper face, No. 1, fig. 3. It is used principally in tailing joists and beams on wall-plates and templets, and the cog is here made narrower, because the end of the joist or rider coming immediately beyond the plate, that part which forms the shoulder of the notch would be liable, on being strained, to be chipped off or torn away, if it were not kept as long as possible; and it is not of so much importance to guard against weakening a wall-plate which is supported along its whole length, as a beam, binder, or principal rafter, which rests on distant points alone. No. 2 of the same figure shows another mode of tailing on joists and beams by a dovetail notch, which, to distinguish it from the flat notches, Nos. 2 and 4, fig. 2, is called corking, or cogging also, though the operation certainly is not cogging. This is a good mode if the timber be so well seasoned as not to be likely to shrink more; but it would be improved by allowing the rider to take a bearing in a notch like that to No. 1 before the dovetail commenced, as at No. 3, for in the ordinary mode it is weakened in a point of great importance. Whatever notches and cogs for beams and joists are required in wall-plates and templets, should be made before they are set on or in a wall; for, as they are always bedded in mortar, anything that may break the set must be avoided. A cog-hold is best obtained through the agency of a chair of cast-iron, which should, however, be itself cogged or joggled to a stone templet laid in the wall under it, and be capped or covered by another broad flat stone, as an inverted templet, with a joggle from the chair running up into it.

Tenoning implies mortising also as a matter of course. They are the names of the two operations necessary to one result,—that of producing a connection between two pieces by inserting part of the end of one into a hole of similar size cut in the side or face of the other. A tenon is formed by cutting in on each side or edge of a piece of timber, near its end, transversely, to a certain depth, or rather, leaving a certain part of the breadth or depth uncut, and then cutting in longitudinally from the ends as far from each edge as the transverse cuts have been made in depth, thus removing two square prisms and leaving a third undivided. This is the tenon. An excavation in the side of a piece of timber, of a certain depth, in the direction of its thickness, parallel to its edges, and bounded lengthwise by lines at right angles to them, is a mortise. Tenons and mortises are made of exactly corresponding size, and are most frequently at equal distances from one or the other side or edge of the two pieces to be conjoined; and for the most part, too, every angle formed in the process of tenoning, both internal and external, is a right angle. Tenons are called joggles in some situations, when they are not intended to be borne upon, and their use is merely to keep the piece of timber to which they belong steadily in its place, without being liable to slight accidents from lateral pressure or violence. In combining timbers by means of mortises and tenons, to produce as great a degree of strength as possible, it must be obvious that the object to be kept in view is to maintain the end or tenon of the one as large and efficient as it may be, and weaken the other as little as possible in forming the mortise. For the efficiency of the mortised piece in a horizontal bearing, it is clear that as much of its thickness should be below the mortise as possible, as at *a*, fig. 4; for if it be put low, as at *b*, the superincumbent weight on the tenon would more readily split or rend it in the direction of the grain, as indicated; but the case is inverted with the tenoned pieces. With the mortise at *a* the tenon could only have the efficacy of so much of the piece to which it belongs as there is of it above its under surface, which is a very small part of its depth; whereas with the tenon at *b* it would command the power of the greatest part of the depth. To guard as much as possible against the danger of too great a mortise and too small a tenon on one side and the other, and to obviate the difficulty arising from the efficiency of one or the other of the two pieces being affected by putting the tenon too high or too low, a compound, called a tusk tenon, is used for almost all horizontal bearings of any importance, especially to joists and binders, to trimmers, beams, girders, bressummers, &c. The body of the tenon in this is a little above the middle of the end, and it runs out 2, 3, or 4 inches, or more, as the case may require. Below it the tusk protrudes, and above it the shoulder is cut down at an obtuse angle with the horizontal line, giving the strength of the whole depth of the timber above the under tusk to the tenon, and giving it a bearing in a shallow mortise, whilst a greater depth of the mortised piece than the tusk rests on receives the body of the tenon, and so protects its comparatively narrow margin from undue pressure. The diagram No. 1, fig. 5, shows the tusk tenon, with the section of a beam into which it is mortised, and No. 2 indicates perspectively the appearance of the mortise in front. Pinning is the insertion of nearly cylindrical pieces of wood or iron through a tenon, to detain it in the mortise, or prevent it from being drawn out by any ordinary force. For this purpose the pin is inserted either in the body, or beyond the thickness, of the mortised piece, as indicated at *a*, fig. 5, or at *a*, fig. 6. Wedging (see *b*, *b*, No. 2, fig. 25) is the insertion of triangular prisms, whose converging sides are under an extremely acute angle, into or beside the end of a tenon, to make it fill the mortise so completely, or bind it so tightly, that it cannot be easily withdrawn. The wedging of tenons also assists in restoring to the mortised piece of timber much of the strength it had lost by the excision of so much of its mass, which indeed the tenon itself does if it fit closely in every direction; but the assistance of the wedge renders the restoration more perfect than the tenon could secure of itself, by compressing the fibres of both, longitudinally to those of the one, and transversely to those of the other, thus removing the tendency of the mortised piece to yield in any degree in the weakened part, though it cannot make up the loss in its tenacity occasioned by the scission of its fibres.

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Pinning.

Wedging.

In scarfing, cogging, and notching, the shoulders are

always cut in with the saw; but the cheek is for the most part struck out with the mallet and chisel, or adze, as may be most convenient. Tenons should be made entirely with the saw. Mortises are generally bored at the ends with an auger whose diameter equals their thickness; the intervening part is taken out with a wide chisel, cutting in the direction of the fibre; and the ends are squared down with a chisel whose breadth just equals the thickness of the mortise. Wood pins must be rent to insure the equal tenacity of their whole mass. Wedges are cut with the saw, but straight-grained stuff is always preferred for them.

Bond-timbers and wall-plates should be carefully notched together at every angle and return, and scarfed at every longitudinal joint. The scarf shown at fig. 1, Plate XXIV., is sufficient; and the notch at No. 3, fig. 2, may be preferred where notching is required; neither pinning nor nailing, however, can be of great use to either the notch or the scarf. Bond-timbers are passed along and through all openings, and are not cut out until such openings are to be permanently occupied, that is, by windows with their sash-frames, &c., because they assist in preventing irregular settlements, by helping to carry the weight of a heavy part along the substruction generally, instead of allowing it to press unduly upon the part immediately under it.

It is the duty of the carpenter to supply the bricklayer or mason with wood bricks in sufficient quantity, and to direct him where they should be placed to receive the joiner's fittings, or the battening, which the carpenter himself may have to put up for the plasterer.

...tres for ...es. The carpenter makes and fixes or sets centres of all kinds, whether for single arches or niches, or even in bridge construction. Large centres are framed in distinct ribs, and are connected by horizontal ties; whilst small ones are made of mere boards cut to the required sweep, nailed together, and connected by battens notched into or nailed on their edges. Precision and stability are nevertheless equally and absolutely necessary, as it is impossible for an arch to be turned or set correctly on an incorrect or unstable centre.

...rs. Descriptions of various sorts of flooring are noticed in the earlier part of this article as for fireproof structures; and also under *Brickwork* and *Mason-work*. The timbers or framework of ordinary house and warehouse floors is called naked flooring, and it is distinguished as single, double, and framed. Of these the first, under ordinary circumstances, is the strongest.

...le ...ring. Single flooring (Plate XXV. figs. 1, 2) consists of one row or tier of joists alone, bearing from one wall or partition to another, without any intermediate support, and receiving the flooring boards on the upper surface or edges of the joists, and the ceiling, if there be one, on the lower. Joists in single floors should never be less than 2 inches in thickness, because of their liability to be split by the brads or nails of the boards if they are thinner; and they should never be much more, because of the keying of the ceiling, which is injuriously affected by great thickness of the joists. Twelve inches from joist to joist is the distance generally allowed; that dimension, however, from centre to centre of the joists would be better. Strength to almost any extent may be given by adding to the depth of the joists, and diminishing the distance between them; and they may be made firm, and be prevented from buckling or twisting, by putting struts between them. The struts are short pieces of batten, fig. 31, which should not be less than an inch, and need not be more than an inch and a half thick, and 3 or 4 inches wide, placed diagonally between the joists, to which they are nailed, in a double series, or crossing, as indicated by the full and dotted lines in Plate XXIV. fig. 7; and they should be made to range in a right line, that none of their effect may be lost; and these ranges

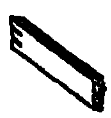


FIG. 31.—Strut.

or rows should be repeated at intervals not exceeding 5 or 6 feet. The struts should be cut at the ends with exactly the same inclination or bevel, to fit closely. Great care should be taken, too, not to split the struts in nailing; but the trouble of boring with a gimlet is saved by making a slight nick or incision with a wide-set saw for each nail, of which there should not be less than two at each end; and the nails used should be clasp-nails. If the struts were notched into the joists, as in fig. 32, it would add very materially to their efficiency, but perhaps not in proportion to the additional labour it would involve. This strutting should be done to single flooring under any circumstances, as it adds materially to its firmness and indeed to its strength, by making the joists transmit any stress or pressure from one to another.

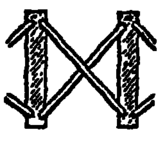


FIG. 32.—Herring-bone Strutting.

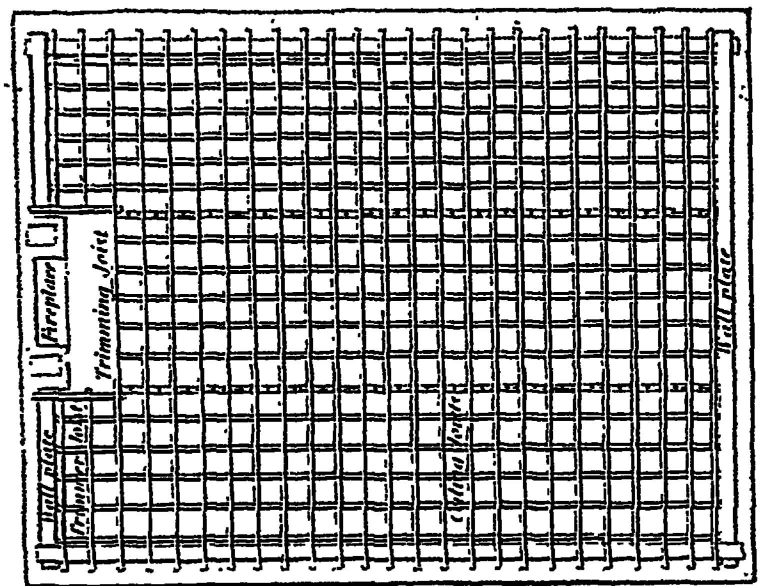
The efficiency of single flooring is materially affected by the necessity which constantly occurs in practice of trimming round fire-places and flues, and across vacuities. Trimming is a mode of supporting the end of a joist by tenoning it into a piece of timber crossing it, and called a trimmer, instead of running it on or into the wall which supports the ends of the other joists generally. A trimmer requires for the most part to be carried or supported at one or both of its ends by some of the joists, which are called trimming joists, and are necessarily made stouter than if they had to bear no more than their own share of the stress. Commonly it is found enough to make the trimmers and trimming joists from half an inch to an inch thicker than common joists. In trimming, tusk tenons should be used; and the long tongue or main body of the tenon should run not less than 2 inches through, and be draw-pinned and wedged, moreover, if it do not completely fill the mortise in the direction of the length of the latter. Trimmi...

The principal objection, however, to single flooring is, that sound readily passes through, the attachment of the boards above and of the ceiling below being to the same joists throughout. Another objection, and one already referred to, is the necessity of making the joists so thin, not to injure the ceilings, that they with difficulty receive the flooring brads in their upper edges without splitting. A partial remedy for both these disadvantages is found in a mode sometimes adopted of making every third or fourth joist an inch or an inch and a half deeper than the intervening joists; and to these, ceiling joists are notched and nailed, or nailed alone, as shown in Plate XXIV. fig. 7. This, by diminishing the number of points of contact between the upper and the lower surface, for the ceiling joists must be carefully kept from touching the shallower joists of the floor, is less apt to convey sound from one story to another, and allows conveniently thin joists to be used for the ceiling without affecting those of the floor. Objections to single floors.

Double flooring (see Plate XXIV. fig. 8, Nos. 1 and 2, and Plate XXV. fig. 3) consists of three distinct series of joists, which are called binding, bridging, and ceiling joists. The binders in this are the real support of the floor; they run from wall to wall, and carry the bridging joists above and the ceiling joists below them. Binders need not be less and should not be much more than 6 feet apart, that is, if the bridging or flooring joists are not inordinately weak. The bridging joists form the upper tier, and are notched down on the binders with the notch No. 5, Plate XXIV. fig. 2. The ceiling joists range under the binders, and are notched and nailed as shown at No. 1, fig. 8; but the notch must be taken entirely out of the ceiling joists, for the lower face or edge of the binder may not be wounded by any means or on any account, and, moreover, no good would be gained in any other respect by doing so. When Double flooring.

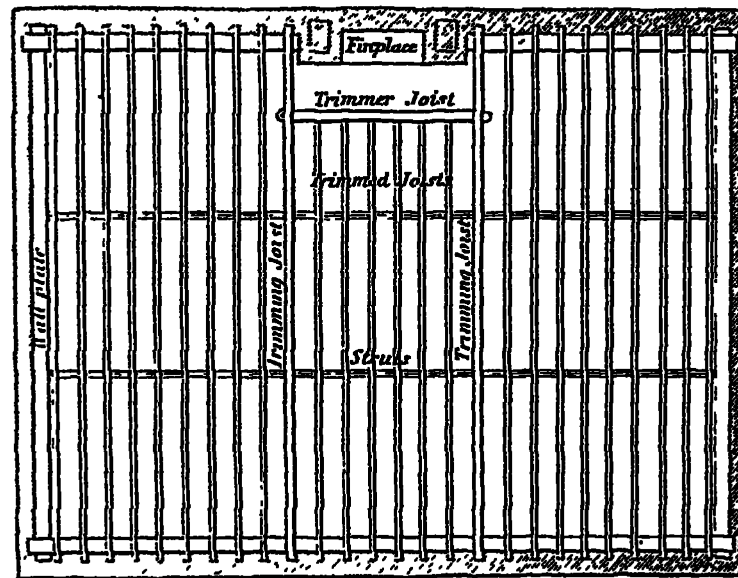
FLOORING AND PARTITIONS.

Fig 2.



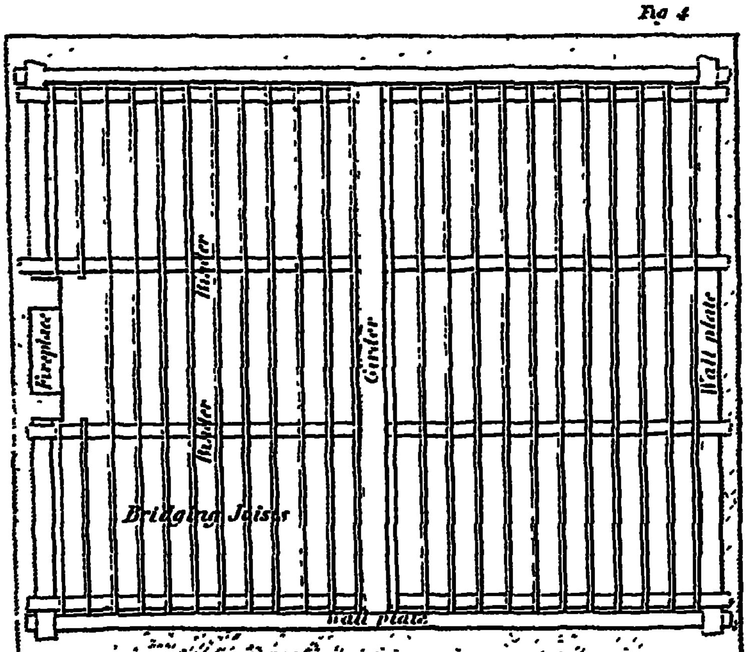
Plan of Single Flooring or Joists only.

Fig 1.



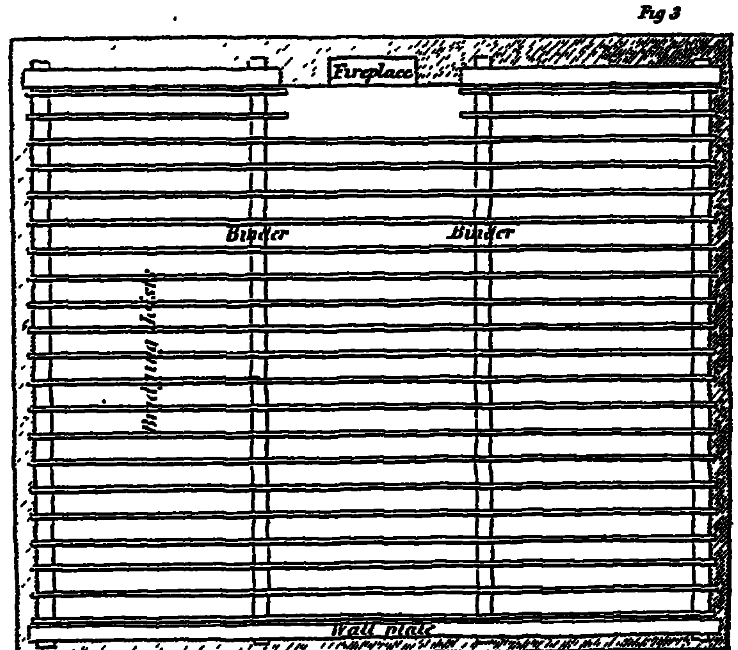
Plan of Single Flooring or Joists only

Fig 4



Plan of Framed Floor, or Girder, Binders & Bridging Joists.

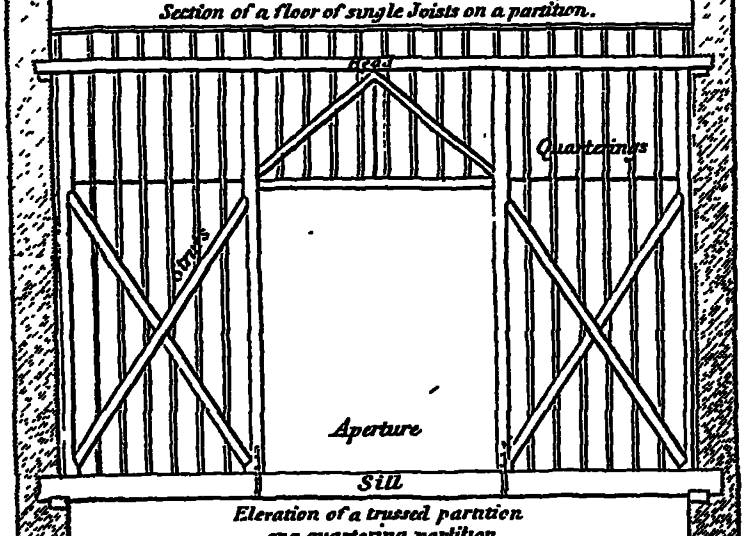
Fig 3



Plan of Double Flooring, or Binders & Joistings

Fig 5

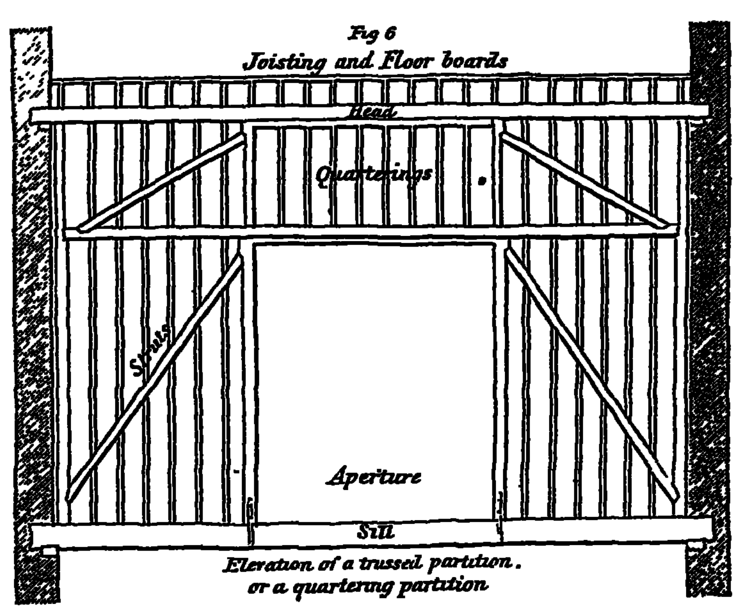
Section of a floor of single Joists on a partition.



Elevation of a trussed partition or a quartering partition

Fig 6

Joisting and Floor boards



Elevation of a trussed partition. or a quartering partition

it is an object to save height in the depth or thickness of this species of floor, the ceiling joists may be tenoned into the binders, instead of being nailed to them; in this case the latter must be chase-mortised on one side, fig. 33, for the convenience of receiving the former when they are themselves set and fixed. A chase is a long wedge-formed groove of the breadth or thickness of the mortise, of which it is indeed an elongation, so that the tenon at one end of the ceiling joist being inserted in the regular mortise in the binder prepared for it, that at the other end is driven along the chase up to its place in the mortise in the next binder. When ceiling joists are thus chase-mortised, their lower or under faces are allowed to come a little below the under face of the binders, and the space across is firred down by slips not wider than the ceiling joists are thick. No. 2, fig. 8, shows a transverse compartment, or bay, of a floor in this manner; but it is not so good a one as the preceding; for, besides the weakening of the binders, by cutting so many mortises and chases in them, it is almost impossible to give the ceiling floor the degree of firmness and consistency it possesses in the other way, besides requiring the firring down on the binders. The same space would be better gained by cutting the bridging joists so much lower down; as they may, with the sort of notch indicated above, be let down fully half their depth without great injury to either bridging joists or binder, for they can always be made to fit tightly or firmly, and very little more labour is involved in notching deeply than slightly.

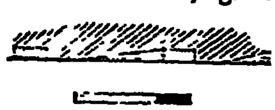


FIG. 33.—Chase Mortise.

Framed flooring. Flooring is said to be framed when girders are used together with binding, bridging, and ceiling joists (see Plate XXIV. fig. 9, Nos. 1 and 2, and Pl te XXV. fig. 4).

Girders. Girders are large beams, in one or more pieces, according to the length required, and the size and strength of which timber can be procured. They are intended for longer bearings than mere binders may be trusted at, and may be strengthened by forming a built beam. The principle of constructing girders of any depth, says Tredgold, in his *Carpentry*, is the same as that of building beams, and when properly conducted they are as strong as any truss can be made of the same depth. The most simple method consists in bolting two pieces together, with keys between to prevent the parts sliding upon each other,—the upper one of hard compact wood, the lower of tough straight grained wood. The joints should be at or near the middle of the depth; the thickness of all the keys added together should be greater than one-third more than the whole depth of the girder; and if they be made of hard wood, the breadth should be about twice the thickness. They may be held together by bolts. Fig. 34 is a good form held by bands, and, if the upper timber be cut so as to be smaller towards the ends, would admit of these hoops being driven on till perfectly

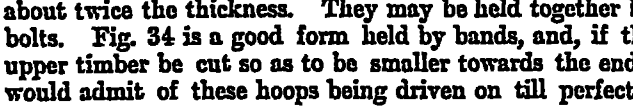


Fig 34

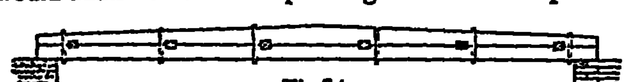


Fig 35

FIGS. 34, 35.—Girders.

tight. In fig. 35 the parts are tabled or indented together instead of being keyed, and a king-bolt is added to tighten the joints. Girders may be further strengthened to almost any extent by trussing; but to be efficient, the height of the truss must always be greater than the depth of the beam itself, and the strength is increased by extending that height as the space or bearing increases. A truss is indeed a wooden arch, whose lateral thrust will of course be greater the smaller the angle subtended by it, and *vice versa*. It has been a commonly received opinion, that a truss less than the depth of a girder adds materially to its strength; but experiments have proved that very little advantage is gained by such a one, even when executed in the best manner, and that, badly executed, the beam or girder is weaker with the truss than without it. In some situations the flooring joists can be raised to a certain height to allow of the head of the truss, which is usually made of iron, being placed at a sufficient height to be truly

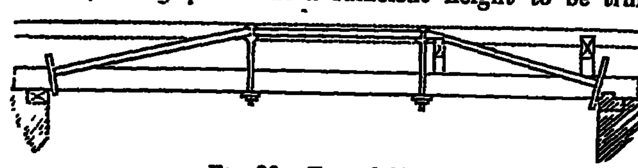


FIG. 36.—Trussed Girder.

efficient. Such is the trussed girder shown in fig. 36, intended for a great length. A common mode of strengthening a beam or bressummer, is to cut the timber in hale longitudinally, whereby any defects in the interior can be seen; then to reverse the pieces, end for end, and bolt them well together. Some additional strength is obtained by putting between the timbers a plate of wrought iron about the depth of the beam and about half an inch in thickness, and then bolting the three together, as in Plate XXIV. fig. 9, No. 3.

Binders are made dependent on the girders by means of double tusk tenons, and on and to them the bridging and ceiling joists are attached as above described. Plate XXIV. fig. 9, No. 1, shows the transverse section of a compartment or bay of a framed floor; No. 2 the same longitudinally of the girder and of the bridging and ceiling joists, and transversely of the binders. Plate XXV. fig. 1, is the plan of a single floor of joists tailing in on wall-plates with two chains of struts, and trimmed to a fire-place. Fig. 2 is a floor similar to fig. 1, with ceiling joists nailed to deeper flooring joists at intervals, as in Plate XXIV. fig. 7. Fig. 3 is the plan of a double floor; and fig. 4 is that of a framed floor of joists, bays of which are shown in section in Plate XXIV. figs. 8, 9. It is to be observed, with reference to the diagram fig. 9, No. 1, that binders ought not to be framed into the girders opposite to one another, as they are here shown to be as a matter of convenience, since the girder is unduly weakened by being mortised on both sides at the same place. Cast-iron shoes render mortising the one forming a tenon upon the other almost unnecessary; and in like manner cast-iron shoes laid into a wall upon stone templets give a good and safe bearing to the girders; but it is not everywhere that cast-iron shoes are attainable, and mortises and tenons may be made anywhere. Plans of floors.

Mediæval flooring. The above descriptions of the three sorts of flooring apply to floors which are to have a ceiling as in house building, or may be left open, as usual in warehouses. But in house building according to the practice of the mediæval period, these timbers would be left exposed. They would all require to be planed smooth, the girders moulded, the binders partly so, and the joists perhaps only stop-chamfered, which is done by cutting the arris of the timber to an angle along its whole length, but stopping short of the ends by a few inches, when it is returned into the arris by a cant. The underside of the joists in a framed floor may be lined with chamfered boarding or formed into panels and ornamented,—a boltel or a set of mouldings forming a frame or cornice all round against the binder. The girders would rest upon stone corbels, either moulded or decorated with foliage or figures, or all three united. Viollet le Duc, in his valuable *Dictionnaire raisonné de l'Architecture*, gives several examples of such a floor,

of one of which we avail ourselves, from a house at Rheims of the 15th century (fig. 37). He gives an example also of

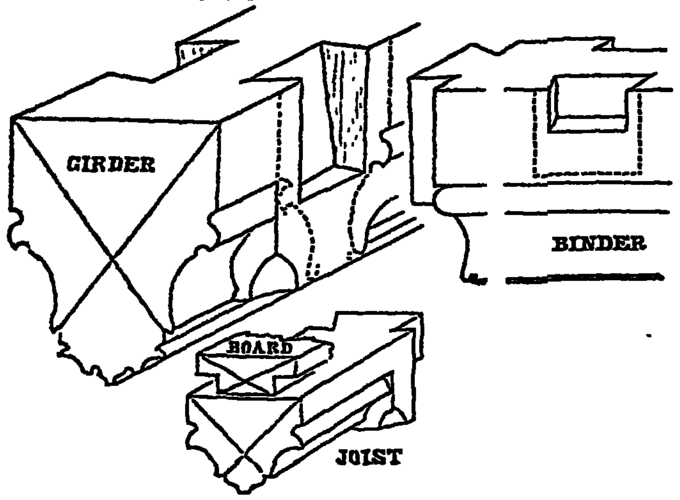


FIG. 37.—Mediæval Flooring.

a floor formed of a girder into which joists are laid formed of square timbers cut in half through the diagonal. These are fixed close together like a succession of v's, thus vvvvv, and boarded over. The top of the angle space formed by two joists is filled up with a small angle fillet presenting a flat surface. The whole effect is unique.

In mediæval carpenters' work it was always the rule only to mould the useful members, and so it was also as regards the carving. Most of the old wood carving is so contrived as to be wrought out of the same plank or thickness as that which is moulded, or else is a separate piece of wood, in a spandril for instance, enclosed within the constructional members. In joining their work, which was of oak, they trusted entirely to tenoning and pinning with stout oak pins.

lars. Although cast-iron columns and stanchions have for some years been preferred to timber posts as supports to girders of warehouse floors, lately the latter have again come into use from their known greater resistance to fire, whereas cast-iron soon succumbs to the great heat and the effects of water upon it. Such posts are usually made of fir or of oak, the dimensions of which vary according to their compound of crushing force and stiffness which is as 25 to 40. The caps to them should be long, so that they may not press into the girders, and if practicable, iron dowels should pass through the girders to catch the bases of the posts in the floor above.

rtitions. Partitions of timber are called quartering partitions, and they are generally framed. Common quartering partitions, which rest on a wall or floor, and have nothing to carry, consist merely of a sill, a head, and common uprights called studs to receive the lath for plastering; these last may be simply joggled or tenoned into the head and sill, as shown in Plate XXIV. fig. 4, *c*, and stiffened by struts or stretching pieces put between them and nailed. When, however, a quartering partition is over a vacuity, or rests only on certain points, and has, moreover, to sustain a weight, a floor perchance, it is framed and trussed with king or queen posts and trussing pieces as to the tie-beam of a roof, and is thence called a trussed partition; and the filling in of common uprights or quarters for the laths is generally performed by joggling them at one end into either head or sill, and nailing them securely to the trussing pieces. In the diagram, Plate XXV. fig. 5, it is supposed that an opening or doorway is to be made in the partition, so that the timbers of the truss are placed around it with queen-posts, and a small internal truss is put over the door-head to prevent it from sagging, and to carry the long part of the partition, which we supposed required to bear a floor, so that the partition acts also, in fact, the part of a trussed girder in the most available form. Fig. 6 presents another method of framing a similar partition. Such partitions should be set up in every story before the beams and joists of the floors are laid, that their horizontal timbers may be notched on to the wall-plates, and that the joists or binders may be notched on to them if occasion require it; but they should be fixed rather below than above the level of the wall-plates, because they are not liable to settle down so much as the walls, though even that will depend in a great degree on the nature of the walling, and its liability to yield. As the whole weight on partitions is supported by the principal posts, their scantlings must be first considered, which should be done in two different ways: first, when the studs are to be filled in with brickwork and rendered thereon, when they are called brick-nog partitions; or secondly, when they are to be lathed and plastered on both sides, or to be wainscoted. Thin partitions of wood only are called framed partitions and are considered in the portion relating to the joiner.

Roofing is another very important branch of the art of carpentry. The most simple form is a shed-roof or lean-to, which is merely obtained by pieces of wood being laid across in the position of an inclined plane to throw off the water. Rectangular buildings are usually covered by a roof in the form of a prism, the vertical section of which is an isosceles triangle. The height of this, or as it is technically called, the pitch of a roof, has varied in different ages, to suit the exigencies of the climate or the taste of the designer. A few examples showing the insertion of the foot of a principal rafter into a tie-beam, the struts into a post, and the heads of struts, are given in Plate XXIII. Roofi

To relate all the specialities which the carpenter may have to do in some particular buildings, as a church, for instance, would far exceed our limits. The mode of executing such things would be the same as already described, the style only making a difference in the result. Pewing or benching—the pulpit and reading-desk, stalls, screenwork, font cover, gallery front, &c.—all depend on the architect's designs. Again, shop fronts are now almost a speciality, together with shop-fittings; and among the minor things in a house are the cupboards, closets, bath, cisterns, kitchen-dresser, plate-rack, dust-bin when not of wholly of brick,—also stable fittings if the improved iron fittings be not used. Centering for arches and for bridges, wharf-walls, spires, turrets, belfries, church bell hangings, gables, are all embraced in carpenter's work, as well as timber houses, the manner of framing which, and the names of the different timbers, will be found described in Le Muet's work (1747) and others of that period, and illustrated in many valuable publications, by Nash, Richardson, Habershon, Clayton, Viollet de Duc, Parker, Dollman, and others; and not least of such works in timber are the barn, porches, lych gates, palings, with chests and presses, and tables and chairs formerly. Speci of car try.

Pugging floors, firring down joists, bracketing and cradling for plastering, and some other things, are operations performed indifferently by the carpenter or the joiner, as less or greater precision is required in the performance.

See Moxon, *Mechanick Exercises*, 4to., 1679; Godfrey Richards, *Translation of the First Book of A. Palladio*, 8vo, 1676; Smith, *Carpenter's Companion*, 8vo, 1735; Price, *British Carpenter*, 4to, 1733–35; Batty Langley, *Builder's Complete Assistant*, 8vo, 1738, and his *Builder's and Workman's Treasury of Designs*, 4to, 1740; Swan, *Carpenter's Complete Instructor*, 4to, 1759 and 1768; Pain, *British Palladio*, fol., 1786 and 1804, and his *Practical House Carpenter*, 4to, 1774; Nicholson, *Carpenter's New Guide*, 4to, 1792, his *Builder's New Director*, 4to, 1824, and his *Architectural Dictionary*, 4to, 1835; Tredgold, *Principles of Carpentry*, edit. by Barlow, 4to, 1853; Weale, *Carpentry*, 4to, 1849; Newland, *Carpenter's Assistant*, &c., fol., 1860; Laxton, *Examples of Building Construction*, large fol., 1855–58; Tarbuck, *Encyclopædia of Practical Carpentry and Joinery*, &c., 4to, 1857–59; A. W.

Pugin, *Chancel Screens*, 4to, 1851, and his *Details of Ancient Timber Houses*, 4to, 1836; Bury, *Ecclesiastical Woodwork*, 4to, 1847; Brandon, *Analysis of Gothic Architecture*, 4to, 1849: Dollman, *Ancient Pulpits*, 4to, 1849; A. Pugin, *Ornamental Gables*, 4to, 1831; and the following foreign publications: Jousse, *Le Theatre de l'art de Charpentier*, fol., 1650; Le Muet, *Manière de bien bastir*, fol., 1623, translated by Pricke, fol., 1670 and 1675; Emy, *L'Art de la Charpenterie*, fol., 1841-42; Krafft, *L'Art de la Charpenterie*, fol., 1805; *L'Art de la Charpente*, fol., 1819-22, and Supplement by Thiollet, fol., 1840; Viollet de Duc, *Dictionnaire*, 8vo, 1857, &c.

Joinery.

Joinery is one of the useful arts which contributes most materially to the comfort and convenience of man. As the arts of joinery and carpentry are often followed by the same individual, it appears at first view natural to conclude that the same principles are common to both these arts; but a closer examination of their objects leads to a different conclusion. The art of carpentry is directed almost wholly to the support of weight or pressure, and therefore its principles must be found in the mechanical sciences. In a building it includes all the rough timber-work necessary for support, division, or connection; and its proper object is to give firmness and stability. The art of joinery has for its object the addition in a building of all the fixed wood-work necessary for convenience or ornament. The joiner's works are many of them of a complicated nature, and require to be executed in an expensive material; therefore joinery requires much skill in that part of geometrical science which treats of the projection and description of lines, surfaces, and solids, as well as an intimate knowledge of the structure and nature of wood. A man may be a good carpenter without being a joiner at all; but he cannot be a joiner without being competent, at least, to all the operations required in carpentry. The rough labour of the carpenter renders him in some degree unfit to produce that kind of accurate and neat workmanship which is expected from a modern joiner; but it is no less true, that the habit of neatness and the great precision of the joiner make him a much slower and less profitable workman than the practised carpenter in works of carpentry. In carpentry, as before observed, framing owes its strength to the form and position of its parts; but in joinery, the strength of a frame depends upon the strength of the joinings. The importance, therefore, of fitting the joints together as accurately as possible is obvious. It is very desirable that a joiner should be a quick workman, but it is still more so that he should be a good one; that he should join his materials with firmness and accuracy; that he should make surfaces even and smooth, mouldings true and regular, and the parts intended to move so that they may be used with ease and freedom. It is also of the greatest importance that the work, when thus put together, should be constructed of such sound and dry materials, and on such principles, that the whole should bear the various changes of temperature and of moisture and dryness, so that the least possible shrinkage or swelling should take place.

Progress of joinery. In early times very little that resembles modern joinery was known; every part was rude, and joined in the most artless manner. The first dawnings of the art appear in the thrones, stalls, pulpits, and screens of our cathedrals and churches; but even in these it is of the most simple kind, and is indebted to the carver for everything that is worthy of regard. Whether in these monuments the carver and the joiner had been one and the same person we cannot now determine, though we imagine, from the mode of joining in some of them, that this was the case. With the revival of classic art great changes took place in every sort of construction. Forms began to be introduced in architecture which could not be executed at a moderate expense without the aid of new principles, and these principles were discovered and published by practical joiners. As might naturally be expected, these authors had but confused notions, with their scanty geometrical knowledge; and, accordingly, their descriptions are often obscure, and sometimes erroneous. The change from the heavy mullioned casement and its guard of iron bars to the sash windows necessitated some new method of protection, and boxing shutters were invented. The framed wainscot of small panels gave way to the large bolection moulded panelling. Heavy doors, which were fomerly hung on massive posts, or in jambs of cut stone, were now framed in light panels, and hung in moulded dressings of wood. The scarcity of oak timber, and the expense of working it, led to the importation of fir timber from the north, which gradually superseded all other material except for the choicest works. But the art is still far short of perfection, and in some respects it seems to have retrograded. It is seldom that large glued-up panels will now stand well. Mouldings of great girth give at the mitres, doors wind, and skirtings shrink from the floors in a way seldom seen in old houses. The sashes, perhaps, are made better than the heavy barred windows of a century and a half ago. In no other respect, however, has joinery made the progress which has been made in other arts. The improved state of machinery has also done but little for its excellence, though the circular saw-bench, the planing-machines, the moulding-machines, and the mortising-machines have done much to reduce the cost of labour. This last machine was suggested in the seventh edition of this work (1830), attention having been drawn to the subject from the improvements in the art of block-making, and it is now used in most of the large establishments throughout the country.

Tools. The joiner operates with saws, planes, chisels, gouges, hatchet, adze, gimblets, and other boring instruments (which are aided and directed by chalked lines), gauges, squares, hammers, mallets, and a great many other less important tools; and his operations are principally sawing and planing in all their extensive varieties, setting out, mortising, dovetailing, &c. Descriptions of the tools, with instructions for using them, may be found in Moxon's *Mechanick Exercises*, 4to, London, 1677–80, and in Nicholson's *Mechanical Exercises*, London, 1812.

There is likewise a great range of other operations, none of which can be called unimportant, such as paring, gluing up, wedging, pinning, fixing, fitting, and hanging, and many things besides which depend on nailing, &c., such as laying floors, boarding ceilings, wainscoting walls, bracketing, cradling, firring, and the like. In addition to the wood on which the joiner works, he requires also glue, nails, brads, screws, and hinges,—and accessorily he applies bolts, locks, bars, and other fastenings,—together with pulleys, lines, weights, white-lead, hold-fasts, wall-hooks, &c., &c.

The joiners' work for a house is for the most part prepared at the shop, where every convenience may be supposed to exist for doing everything in the best and readiest manner; so that little remains to be done when the carcass is ready, but to fit, fix, and hang, that is, after the floors are laid. The sashes and frames, the shutters, back flaps, backs, backs and elbows, soffits, grounds, doors, &c., are all framed and put together, that is, wedged up and cleaned off, at the shop; the flooring boards are prepared, that is, faced, shot, and gauged with a fillister rebate; and the architraves, pilasters, jamb linings, skirtings, mouldings, &c., are all got out, that is, tried up, rebated, and moulded, at the shop. The joiner very often turns the house he has to fit up into a workshop; for benches, and a fire for his glue-pot, are nearly all he requires, should he not have the now usual "general joiner" machine.

s. There is no art in which it is required that the structure and properties of wood should be so thoroughly understood as in joinery. The practical joiner, who has made the nature of timber his study, has always a most decided advantage over those who have neglected this most important part of the art.

It is well known that wood contracts less in proportion, in diameter, than it does in circumference; hence a whole
ly. tree always splits in drying. Mr Knight has shown that, in consequence of this irregular contraction, a board may be cut from a tree that can scarcely be made by any means to retain the same form and position when subjected to various degrees of heat and moisture. From the ash and the beech he cut some thin boards in different directions relatively to their tranverse septa, so that the septa crossed the middle of some of the boards at right angles, and lay nearly parallel with the surfaces of others. Both kinds were placed in a warm room, under perfectly similar circumstances. Those which had been formed by cutting across the tranverse septa, as at A in fig. 38, soon changed their form very considerably, the one side becoming hollow, and the other round; and in drying, they contracted nearly 14 per cent. in width. The other kind, in which the septa were nearly parallel to the surfaces of the boards, as at B, retained, with very little variation, their primary form, and did not contract in drying more than $3\frac{1}{2}$ per cent. in width. (*Philosophical Transactions*, part ii. for 1817; *Philosophical Magazine*, vol. l. p. 437.)

Fig. 38.

As Mr Knight had not tried resinous woods, two specimens were cut from a piece of Memel timber; and to render the result of the observations more clear, conceive fig. 38 to represent the section of a tree, the annual rings being shown by circles. BD represents the manner in which one of our pieces was cut, and AC the other. The board AC contracted 3·75 per cent. in width, and became hollow on the side marked *b*. The board BD retained its original straightness and contracted only 0·7 per cent. The difference in the quantity of contraction is still greater than in hard woods. From these experiments, the advantages to be obtained merely by a proper attention in cutting out boards for panels, &c., will be obvious; and it will also be found that panels cut so that the septa are nearly parallel to their faces, will appear of a finer and more even grain, and require less labour to make their surfaces even and smooth. But as this system would necessitate the rejection of all but the heart of the tree for superior work, a method has been adopted which it is said was first used by the billiard-table makers. Let AC, fig. 39, represent the piece above referred to by the same letters. It will become hollow on the side marked *b*, no doubt because the rings of the wood when cut across are relieved from tension, and endeavour to expand themselves. To counteract this it is customary, in all good work, to rip the plank down the centre, and then to "turn the stuff inside out" as it is popularly called. This is done by reversing the wood, end for end, so as to bring the heart against heart, and the outside against outside, as is shown in fig. 40 (without which the glue joints are sometimes liable to fly), and also so as to reverse the circular parts of the grain.

Fig. 39.


Fig. 40.

In wood that has the larger transverse septa, as the oak, for example, boards cut as BD will be figured, while those cut as AC will be plain.

There is another kind of contraction in wood whilst drying, which causes it to become curved in the direction of its length. In the long styles of framing we have often observed it; indeed, on this account, it is difficult to prevent the style of a door, hung with centres, from curving, so as to rub against the jamb. A very satisfactory reason for this kind of curving has been given by Mr Knight, which also points out the manner of cutting out wood, so as to be less subject to this defect, which it is most desirable to avoid. The interior layers of wood, being older, are more compact and solid than the exterior layers of the same tree; consequently, in drying, the latter contract more in length than the former. This irregularity of contraction causes the wood to curve in the direction of its length, and it may be avoided by cutting the wood so that the parts of each piece shall be as nearly of the same age as possible. But as this would also necessitate the rejection of a great deal of stuff, a simpler method is found, which is always to turn the heart of the wood outwards. Thus, in framing a door, the heart should always go against the jambs, and the sap side to the panels.

Besides the contraction which takes place in drying, wood undergoes a considerable change in bulk with the variations of the atmosphere. In straight-grained woods the change in length is nearly insensible, and hence they are sometimes employed for pendulum rods; but the lateral dimensions vary so much that a wide piece of wood will serve as a rude hygrometer. The extent of variation decreases in a few seasons, but it is of some importance to the joiner to be aware that even in very old wood, when the surface is removed, the extent of variation is nearly the same as in new wood.

It appears from Rondelet's experiments (*L'Art de bâtir*, article "Menuiserie," tom. iv. p. 425, 1814), that in wood of a mean degree of dryness, the extent of contraction and expansion, produced by the usual changes in the state of the atmosphere, was, in fir wood, from $\frac{1}{380}$ to $\frac{1}{75}$ of its width, and in oak, from $\frac{1}{412}$ to $\frac{1}{84}$. Consequently, the mean extent of variation in fir is $\frac{1}{124}$, and in oak, $\frac{1}{140}$; and, at this mean rate, in a fir board about $12\frac{1}{2}$ inches wide, the difference in width would be $\frac{1}{10}$th of an inch. This will show the importance of attending to the maxims of construction we have already laid before the reader; for, if a board of that width should be fixed at both edges, it must unavoidably split from one end to the other.

The kinds of wood commonly employed in joinery are —the oak, the different species of pine, mahogany, and sometimes lime-tree and poplar. Of the oak there are two species common in Britain; that which Linnæus has named *Quercus Robur* is the most valuable for joiners' work; it is of a finer grain, less tough, and not so subject to twist as the other kind. Oak is also imported from the Baltic ports, from Germany (that known as wainscot), and from America. These foreign kinds being free from knots, of a straighter grain, and less difficult to work, they are used in preference to British species. The greater part of joiners' work is executed in fir imported from the north of Europe. Yellow fir is used for outside work, as doors and sashes, and for floors where there is likely to be much wear. Very good red pine deals have been imported from Canada. Inside work is almost always framed of white fir. Some very good panels when not too wide, and excellent mouldings, are made of American pine. White fir is often used for internal work, and yellow pine is much used for mouldings. The forest of Braemar, in Aberdeenshire, furnishes yellow fir of an excellent quality, little inferior to the best foreign kinds. For the general purposes of joinery, the wood of the larch seems to be the best; this useful tree thrives well on the Scottish hills. Some fine specimens of it have been obtained from Blair- Kinds of wood.

Athol. It makes excellent steps for stairs, floors, framing, and most other articles. Mahogany, in joinery, is only used where painted work is improper, as for the hand-rails of stairs, or for the doors and windows of principal rooms. For doors it is not now so often used as it was formerly, its colour being found to be too gloomy to be employed in large masses. Lime-tree, and the different species of poplar, make very good floors for inferior rooms; and may often be used for other purposes, in places where the carriage of foreign timber would render it more expensive. Lime-tree is valuable for carved work, and does not become worm-eaten; but carving is at present seldom used in joinery.

From these timbers, the oak and fir especially, the joiner obtains the battens, fillets, boards, and planks, with which he performs all his works, cutting them into scantlings and thin deals as he requires them.

Battens. Battens are narrow boards running from half an inch to an inch and a half or 2 inches thick, and from 3 to 6 or 7 inches wide. A piece of stuff of too small a scantling to

Boards. be a batten is called a fillet. The term board is applied to sawed stuff when its width exceeds that of a batten, and its thickness does not exceed 2 inches or 2½ inches.

Planks. The term plank is applied to large pieces of stuff whose width is great in proportion to their thickness, and whose thickness nevertheless does not exceed 3 or 4 inches. In London these terms are used in much more restricted senses than they are here described to mean, because of the fixed and regular sizes and forms in which stuff for the joiner's use is for the most part brought to market there. A batten, to a London joiner, is a fine flooring board from an inch to an inch and a half in thickness, and just 7 inches wide. A board is a piece cut from the thickness of a deal whose width is exactly 9 inches; and nearly everything above that width, and not large enough to be called a scantling of timber, is a plank.

Mouldings. Mouldings, in the Roman and Italian styles, as used in joinery, are generally composed of parts of circles, and differ somewhat from those used in stone. (See Plates XIII., &c., illustrating the article ARCHITECTURE, in vol. ii.) Mouldings are almost the only part of modern joiners' work which can, in strictness, be called ornamental, and consequently that in which the taste of the workman is most apparent. The form of them should be distinct and varied, forming a bold outline of a succession of curved and flat surfaces, disposed so as to form distinct masses of light and shade. If the mouldings be of considerable length, a greater distinction of parts is necessary than in short ones. Those for the internal part of a building should not, however, have much projection; the proper degree of shade may always be given, with better effect, by deep sinkings judiciously disposed. The light in a room is not sufficiently strong to relieve mouldings, without resorting to this method; and hence it is that quirked and under-cut mouldings are so much esteemed. The following present

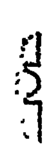
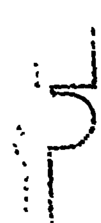
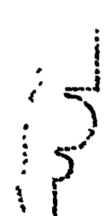





FIG. 41. Rounded Edge. FIG. 42. Bead. FIG. 43. Torus. FIG. 44. Torus and Bead.

the convex side to the eye:—fig. 41 is merely a rounded edge; fig. 42, of small size, is a bead; fig. 43, of larger size, a torus; and fig. 44 shows the torus and bead together. If there be a deep sinking under a bead (as fig. 45), it is called a quirked or cock bead; if there be two



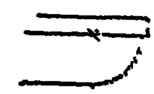



FIG. 45. Quirked Bead. FIG. 46. Double-quirked Bead. FIG. 47. Reeds. FIG. 48. Ovolo.

such sinkings, so as to show three-quarters of a circle in the bead, it is called (fig. 46) a double-quirked bead: two or more beads, side by side (as fig. 47) are called reeds:

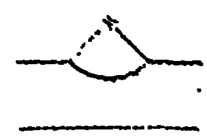
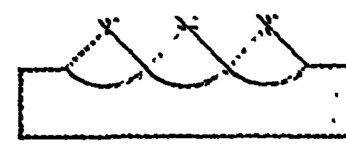



FIG. 49.—Hollow. FIG. 50.—Flutes.

the fourth part of a circle, or half a bead (as fig. 48), is called an ovolo, or quarter round. A moulding composed of two convex parts is also called an ovolo, the upper part

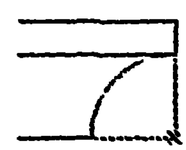
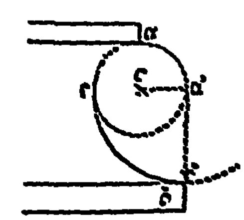
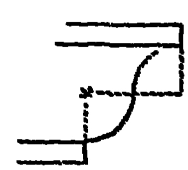
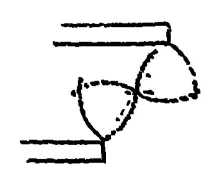



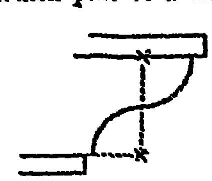
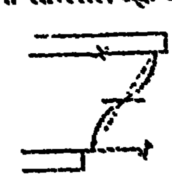
FIG. 51.—Cavetto. FIG. 52.—Scotia.

of the curve being continued round into the bed similar to a quirk, as fig. 44. In concave mouldings a simple curved grooving, as fig. 49, is called a hollow, and two or more

FIGS. 53, 54.—Forms of Cyma recta.

such grooves are flutes, as fig. 50. A hollow forming the fourth part of a circle is called a cavetto, fig. 51; a

FIGS. 55, 56.—Forms of Cyma reversa.

deep hollow between two fillets, as used in base mouldings, is a scotia, fig. 52. Mouldings which are partly convex



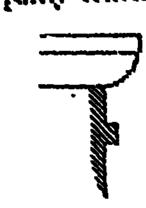



FIG. 57. Rebate. FIG. 58. Groove. FIG. 59. Necking. FIG. 60. Fillet.

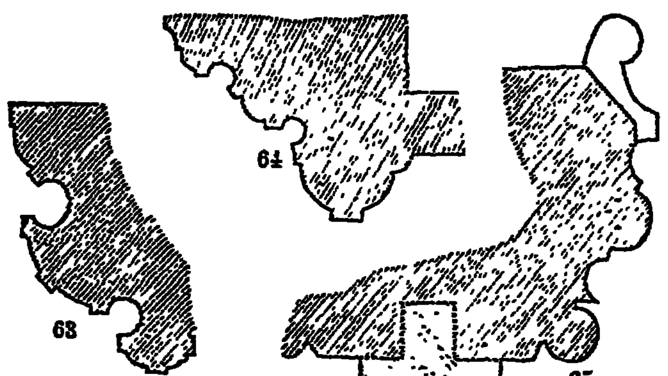
and partly concave, are of two sorts, the cyma recta, as figs. 53 and 54, and the cyma reversa or ogee, as figs. 55 and

56, which may be made of greater or less projection. Grecian mouldings are all similar in principle, but the parts are of conic sections instead of circles, as explained above, p. 473.

A plain square sinking on the edge of a board, as fig. 57, for the purposes of framing, is called a rebate; if away from the edge, as fig. 58, a groove; placed under a cap (as fig. 59), or as a necking (as fig. 60), it is called a fillet; three such fillets under an ovolo, when composing part of the capital of a column, are called annulets. In all kinds of framing the mouldings which rise above the styles are called bolection mouldings (see fig. 82).

The mouldings during the mediæval period used by the carpenter and joiner, who were perhaps the same person, seldom varied from those cut by the mason, except that they were somewhat more refined and less in size, as appropriate to the material out of which they were to be cut. "They are such as would not be executed in any other material; they are sharp, delicate, minute, and quaintly under-cut. Every curve is subtle; every alternation of round and flat and hollow thoughtfully contrived, graceful, and yet vigorous; they are very often unlike any stone mouldings," says Mr G. E. Street, in a lecture in 1865 on "English Woodwork in the 13th and 14th Centuries," printed in the *Transactions of the Royal Institute of British Architects*. "In the stalls at Selby there is an elaborate cap only $1\frac{3}{4}$ inches in height; and at Winchester a band $\frac{5}{8}$ths of an inch in height, and yet consisting of four distinct members, and showing in elevation as many as eight distinct lines." The woodcuts appended will suffice to explain the author's meaning. Fig. 61 is a mullion from stalls at Winchester Cathedral, and fig. 62 from St Mary's Hospital at Chichester. Figs. 63 and 64 are arch mouldings from the same stalls; and fig. 65, the cornice of a screen in Old Shoreham church. Fig. 66 is a cap and base from the stalls at Winchester.

FIGS. 61, 62.—Mediæval Mullions.



FIGS. 63, 64, 65.—Mediæval Mouldings and Cornice.

When an inclined or raking moulding is intended to join with a level moulding, at either an exterior or an interior angle, the form of the level moulding being given, it is necessary that the form of the inclined moulding should be determined, so that the corresponding parts of the surfaces of the two mouldings should meet in the same plane, this plane being the plane of the mitre. This may be otherwise expressed by saying that the mouldings should mitre truly together.

ding
les.

When the length of a joint at an angle is not considerable, it is sufficient to cut the joint in such a manner that when the parts are joined, the plane of the joint shall bisect the angle. This kind of joint is shown for two different angles, by fig. 67, and is called a mitre. When an angle of considerable length is to be joined, and the kind of work does not require that the joining should be concealed, fig. 68 is often employed; the small bead renders the appearance of the joint less objectionable. because any irregularities from shrinkage are not seen in the shade of the quirk of the bead. A bead upon an angle, where the nature of the work does not determine it to be an arris, is attended with many advantages; it is less liable to be injured, and admits of a secure joint without the appearance of one. Fig. 69 shows a joint of this description, which should always be used in passages. Fig. 70 represents a very good joint for an exterior angle, whether it be a long or a short one. Such a joint may be nailed both ways. But the joint represented by fig. 71 is superior to it; the parts, being drawn together by the form of the joint itself, can be fitted with more accuracy, and joined with certainty. The angles of pilasters are often joined by this last method. Interior angles are commonly joined as shown in fig. 72. If the upper or lower edge be visible, the joint is mitred, as in fig. 67, at the edge only, the other part of the joint being rebated, as in fig. 70. In this manner are put together the skirting and dado

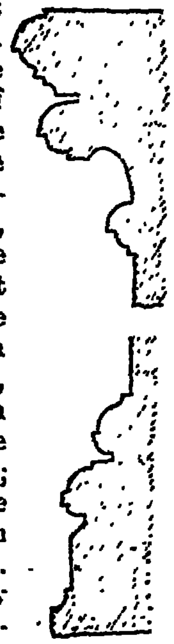


FIG. 66.—Cap and Base from Mediæval Stalls.

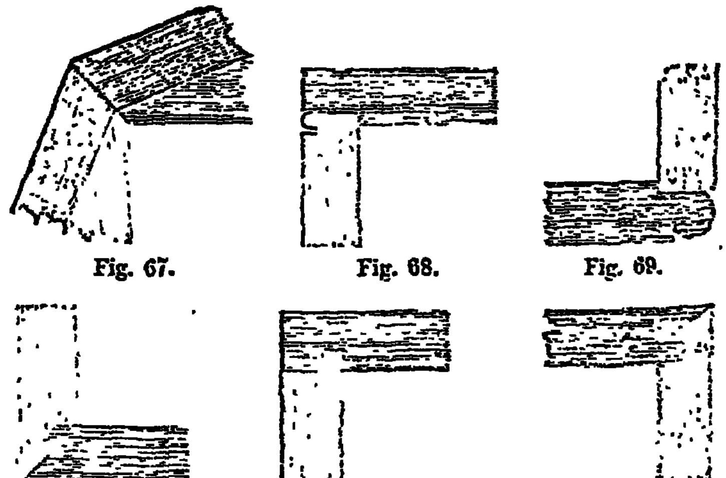


Fig. 67. Fig. 68. Fig. 69.

Fig. 70. Fig. 71. Fig. 72.

FIGS. 67–72.—Different forms of Joints

at the interior angles of rooms, the backs and backlinings of windows, the jambs of door-ways, and various other

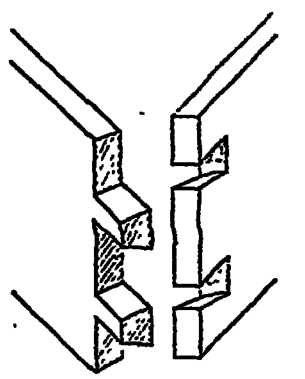


FIG. 73.—Dovetail.

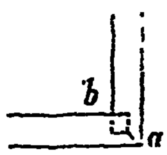


FIG. 74.—Mitre-dovetail.

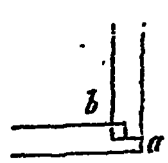


FIG. 75.—Lap-dovetail.

parts of joiners' work. Fig. 73 is an excellent method of joining angles for drawers, frames for lead cisterns, boxes,

&c., and is commonly called a dovetail. If a portion of the junction is cut off at an angle of 45°, as fig. 74, while the portion at *b* is dovetailed, it is called a *mitre dovetail;* while if the portion at *a* (in fig. 75) passes the other portion at right angles, it is called a *lap-dovetail.* A very good joint is shown in fig. 76, the angles being brought together at an angle of 45°, two or more saw curfs are cut with a dovetail saw, and thin pieces of wood glued in as shown; this is called a *keyed mitre.*

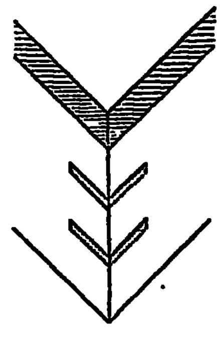


FIG. 76.—Keyed Mitre.

Fig. 77 shows four methods for securing planks together as practised in France during the mediæval period, from Viollet le Duc's *Dictionnaire.* He does not appear to show the junction formed by running a tongue of one piece through another piece and pinning it on the outside, as practised now in England in furniture, as tables, &c.

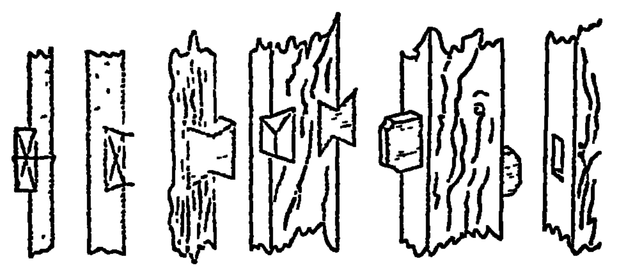


FIG. 77.—Mediæval Joints.

lue. Glue is a viscid tenacious matter used as a cement to connect objects together. The common or animal glue is made from certain portions of animals reduced after certain processes by boiling to the required consistency, and dried in cakes. The best marine glue is composed of caoutchouc dissolved in naphtha, to which shellac is added, and heated until amalgamated. It is insoluble in water, sufficiently solid to give strength, and adhesive to an intense degree. Glue is used principally in putting framed work together, but not at all in fixing; and even for the former purpose it is much less used by good workmen than by bungling hands. When the stuff is well seasoned, and the trying up, setting out, mortising, and tenoning are well and accurately executed, there is no necessity for glue on the tenons and shoulders; the wedges alone need be glued, to attach them to the sides of the tenons, that their effect may not depend on mere compression. Joiners are generally furnished with a cramp, with which to force the joints of framing into close contact; it is either of wood acting by means of wedges, or of iron with a screw. This, too, is unnecessary with good work, every joint of which may be brought perfectly close without great violence of any kind. The cramp will sometimes give bad work the semblance of good, but it cannot make it really so. If any cracking and starting be heard in the joiner's work of a new building, it generally indicates one of two things: either the cramp has been required in putting the framing together, or, having been put together, it has been forced out of winding in fixing, and the constrained fibres are seeking to regain their natural position. A good workman does not require cramp, nor will his work, if he has been supplied with seasoned stuff, ever require to be strained; and consequently the cracking and starting of joiners' work indicate unfit stuff or bad work, or perhaps both, It is true that glued joints will sometimes fly; but when they do, there need be no hesitation in determining the presence of both bad work and stuff in an improper state.

ramping.

Joining with glue.

It is seldom possible to procure boards sufficiently wide for panels without a joint, on account of heart shakes, which open in drying. In cutting out panels, for good work, shaken wood should be carefully avoided. That part near the pith is generally the most defective. If the panels be thick enough to admit of a cross or feather tongue in the joint, one should always be inserted, for then, if the joint should fail, the surfaces will be kept even, and it will prevent light passing through. A very good way also is to glue a piece of strong canvas on the back of the panel when the work is not intended to be seen on both sides. Sometimes plane surfaces of considerable width and length are introduced in joiners' work, as in dado, window backs, &c.; such surfaces are commonly formed of inch or inch and quarter boards joined with glue, and a cross or feather tongue ploughed into each joint. When the boards are glued together, and have become dry, tapering pieces of wood, called keys, are grooved in across the back with a dovetailed groove. These keys preserve the surface straight, and also allow it to shrink and expand with the changes of the weather. It would be an endless task to describe all the methods that have been employed to glue up bodies of such varied forms as occur in joinery; for every joiner forms methods of his own, and merely from his being most familiar with his own process, he will perform his work, according to it, in a better manner than by another, which to an unprejudiced mind has manifestly the advantage over it. The end and aim of the joiner, in all these operations, is to avoid the peculiar imperfections and disadvantages of his materials, and to do this with least expense of labour or material. The straightness of the fibres of wood renders it unfit for curved surfaces, at least when the curvature is considerable. Hence, short pieces are glued together as nearly in the form desired as can be, and the apparent surface is covered with a thin veneer; or the work is glued up in pieces that are thin enough to bend to the required form. Sometimes a thin piece of wood is bent to the required form upon a cylinder or saddle, and blocks are jointed and glued upon the back; when the whole is completely dry it will preserve the form that had been given to it by the cylinder. The curve should be made a little "quicker" than the curve intended, as the stuff will always spring back a trifle on being released. A piece of work glued up in thicknesses should be very well done; but it too often happens that the joints are visible, irregular, and in some places open; therefore other methods have been tried.

Large pieces of timber should never be used in joinery, because they cannot be procured sufficiently dry to prevent them splitting with the heat of a warm room. Therefore, the external part of columns, pilasters, and works of a like kind, should be formed of thin pieces of dry wood; and, if support be required, a post, or an iron pillar, may be placed within the exterior column. Thus, to form columns of wood, so that they shall not be liable to split, narrow pieces of wood are used, not exceeding 5 inches in width. These are jointed like the staves of a cask, and glued together, with short blocks glued along at each joint. Fig. 78 is a plan of the lower end of a column glued up in staves; the bevel at A is used for forming the staves, that at B is used for adjusting them when they are glued together. A similar plan must be made for the upper end of the column, which will give the width of the upper end of the staves. The bevels taken from the plan, as at A and B,

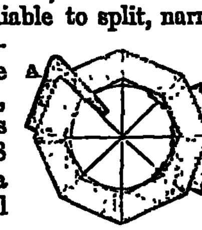


FIG. 78.—Jointing of Column.

are not the true bevels; but they are those generally used, and are very nearly true when the columns are not much diminished. The same method may be adopted for forming large pillars for tables, &c. If a column have flutes, with fillets the joints should be in the fillets, in order to make the column as strong as possible; also, if a column be intended to have a swell in the middle, proper thickness of wood should be allowed for it. When columns are small they may be made of dry wood, and turned in a lathe, when they can be moulded at the same time. Balusters for stairs are made thus. To secure small columns against splitting, a hole should be bored down the axis of each column

ıg If a piece of wood be boiled in water for a certain time, and then taken out and immediately bent into any particular form, and it be retained in that form till it be dry, a permanent change takes place in the mechanical relations of its parts; so that though, when relieved, it will spring back a little, yet it will not return to its natural form. The same effect may be produced by steaming wood; but though both these methods have been long practised to a considerable extent in the art of ship-building, we are not aware that any general principles have been discovered either by experiment or otherwise, that will enable us to apply them in joinery, where so much precision is required. They do not seem to have been tried; and before they can be rendered extensively useful, the relation between the curvature to which the wood is bent, and that which it assumes when relieved, should be determined, and also the degree of curvature which may be given to a piece of a given thickness. The time that a piece of wood should be boiled or steamed, in order that it may be in the best state for bending, should be made the subject of experiments; and this being determined, the relation between the time and the bulk of the piece should be ascertained. A novel and very simple and effective way of boiling sash-bars or thin articles has been adopted,

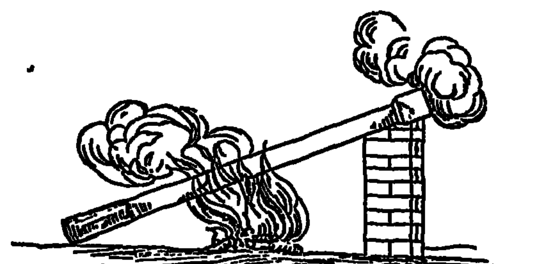
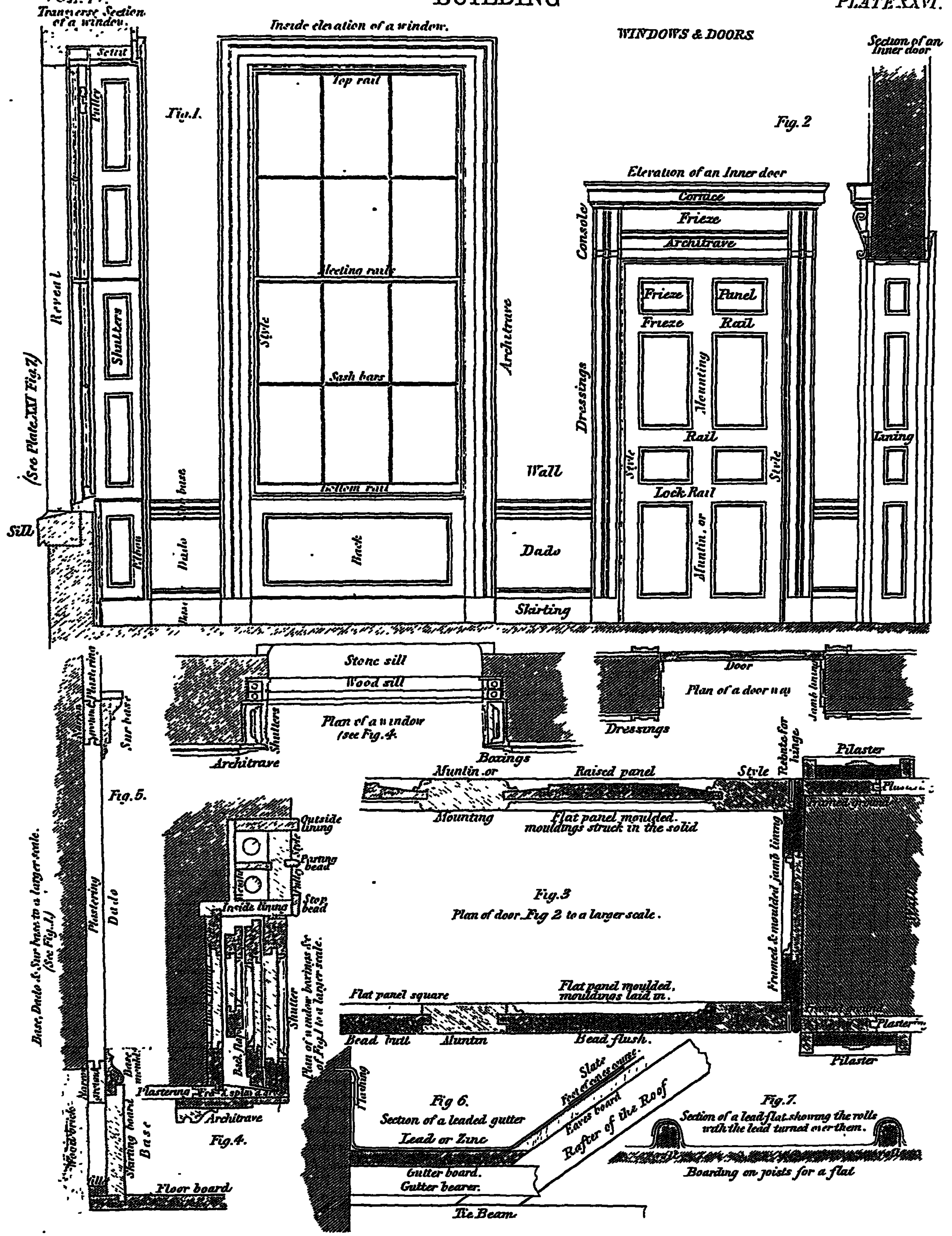


FIG. 79.—Boiling Sash-bars.

as shown in fig. 79. Take a piece of common cast-iron pipe of sufficient diameter, stop up one end with a plug of wood driven tight, fill the pipe with water, raise one end in a sloping position, leaning it on a pile of bricks, and kindle a fire under the pipe. For the joiner's purposes the process might perhaps be greatly improved by saturating the convex side of each piece with a strong solution of glue immediately after bending it. By filling, in this manner, the extended pores, and allowing the glue to harden thoroughly before relieving the pieces, they would retain their shape better.

ning. The object in framing is, to reduce the wood into narrow pieces so that the work may not be sensibly affected by its shrinkage; and, at the same time, it enables us to vary the surface without much labour. Besides this, as the strains from the grain of the wood are in different directions, the work is prevented from winding on its face. From this view of the subject, the joiner will readily perceive that neither the parts of the frame nor the panels should be wide. And as the frame should be composed of narrow pieces, it follows that the panels should not be very long, otherwise the frame will want strength. The panels of framing should not be more than 15 inches wide and 4 feet long, and panels so large as this should be avoided as much as possible. The width of the framing is commonly about one-third of the width of the panel. Frames in joinery are usually connected by mortise and tenon joints, with grooves to receive the panels. Wainscoting, doors, window-shutters, &c., are framed in this manner.

In framing or framed work, the outer vertical bars which are mortised are called styles; and the transverse, those on whose ends the tenons are formed are called rails (Plate XXVI. fig. 2). In doors the open spaces or squares formed internally by the rails and styles are divided in the width by bars parallel to the styles. These are tenoned into the rails, and are called munnions or mountings, or, vulgarly, *muntins*. The frame being formed by trying up, setting up, mortising, and tenoning, the inner or face edges of the styles, and of the highest and lowest rails, and both edges of the muntins and of the inner rails, are grooved with the plough to receive the edges and ends of the filling-in parts or panels of the framework. Panels are either flat, raised, or flush (Plate XXVI. fig. 3). Flat panels are no thicker than the grooves into which they are fitted, and consequently their faces are as much below the surface of the framing as the groove is in from each side of the styles and rails. Raised panels are thicker than the groove in the framing, but are not so thick as to reach the surface; nor is the panel thickened through its whole extent. It fits exactly into the groove, and thickens gradually for an inch or two, and then sets off at a right angle with the surface, increasing suddenly three or four sixteenths of an inch. A panel may be raised on one side only, or on both sides. Flush panels are rebated down from one face to the distance the plough groove is in from the surface of the framing; and the back of a panel thus rebated on one side is worked down to be even with the other edge of the groove, leaving a tongue to fit it exactly; for if it be required to make panels flush on both sides, this is generally effected by filling in on the back or flattened side with an extraneous piece. Panels of external doors and shutters may be rendered more secure by boring them, and inserting iron wires, as noticed in the *Transactions of the Society of Arts*, vol. xxv. p. 106. Framing is not, however, often finished in the manner above described, especially with raised and flush panels; mouldings are generally introduced, and are either struck or worked in the solid substance of the framing, or are in separate pieces or slips, and laid in with brads. If a moulding be struck or laid in on one side only, and the other is left plain, the framing is described as moulded and square, a flat panel being in that case understood; if the panel be raised the framing will be described as moulded with a raised panel on one side, and square or flush on the other. It may be moulded with a flat panel, or moulded with a raised panel, on both sides; and the moulding may, as before intimated, be either struck in the solid or laid in any of the preceding cases. Mouldings which are laid in round the panels of framing are neatly mitred at the angles, and bradded, to appear as much as possible as if they were struck in the solid. In nailing or bradding the mouldings, the brads should be driven into the framework, and not into the panels. Framing with sunk panels, in some kinds of work, has the edges of the rails and styles either stop-chamfered or slightly curved. With a flush panel the moulding is always either a bead, or a series of beads called *reeds*; and is, in the case of a single bead, which is most common, always struck on the solid frame, and the work is called bead-flush; but reeds are generally struck on the panel in the direction of the grain, and laid in on the panel across it, or along the ends; this is termed reed-flush.


WINDOWS & DOORS
Transverse Section of a window.
Inside elevation of a window.
Fig. 1.
Top rail
Meeting rails
Sash bars
Bottom rail
Style
Architrave
Shutters
Reveal
(See Plate XXI Fig. 7)
Sill
Dado
Back
Wall
Skirting
Base
Fig. 2
Elevation of an Inner door
Section of an Inner door
Cornice
Frieze
Architrave
Console
Dressings
Frieze
Panel
Frieze
Rail
Mounting
Rail
Lock Rail
Style
Style
Muntin, or
Lining
Stone sill
Wood sill
Plan of a window (see Fig. 4.
Shutters
Architrave
Boxings
Door
Plan of a door way
Jamb lining
Dressings
Pilaster
Muntin or
Mounting
Raised panel
Style
Rebate for hinge
Flat panel moulded. mouldings struck in the solid
Fig. 3
Plan of door Fig 2 to a larger scale.
Framed & moulded jamb lining
Flat panel square
Flat panel moulded, mouldings laid in.
Bead butt
Muntin
Bead flush.
Plaster
Pilaster
Fig. 5.
Sur base
Plastering
Dado
Base, Dado & Sur base to a larger scale. (See Fig. 1.)
Skirting board
Base
Floor board
Outside lining
Parting bead
Stop bead
Inside lining
Back flap
Shutter
Plan of window boxings &c of Fig. 1 to a larger scale.
Architrave
Fig. 4.
Fig 6.
Section of a leaded gutter
Lead or Zinc
Slate
Eaves board
Rafter of the Roof
Gutter board.
Gutter bearer.
Tie Beam
Flashing
Fig. 7.
Section of a lead flat showing the rolls with the lead turned over them.
Boarding on joists for a flat

Flush panels in inferior works have a single bead struck on their sides in the direction of the grain alone, the ends abutting plainly, and this is termed bead-butt, the fact that the panels are flush being inferred.

The plainest quality of framing, in which it is square on both sides, is used in the fittings of inferior bed-rooms, inner closets, and the plainer domestic offices, but always internally; framing moulded on one or both sides, in rooms and places of a greater degree of importance, and in places where the work may be more generally seen; in some cases a flat panel may be enriched by a small moulding laid on its surface, leaving a margin between it and the larger moulding at its extremities. This may be done in drawing-rooms and apartments of that class, especially if they be in an upper story; and raised panels should be confined to the framed fittings of dining-rooms and other apartments on a ground or principal story. Framing with flush panels is almost restricted to external doors, &c., one side of a door being bead-flush, and the other flat and moulded, perhaps, or the face may be moulded with a raised panel, and the back bead-flush; and this for principal entrances. Bead-butt framing is found in external doors to offices, &c. Partitions between rooms are often made of framing as above described. Lately some sliding partitions have been put forward, one of which consists of two or three large sliding framings, and felt is relied upon to render them sound proof. This is by Stone; while that by Williams consists of a series of framings pivoted at top and bottom, and with the pivots running on grooves at top and bottom, so that the shutters may be formed into a pilaster-like mass at the side of the room.

:ises tenons frames. It is of the utmost importance in framing that the tenons and mortises should be truly made. After a mortise has been made with the mortise chisel, it should be rendered perfectly even with a float,—an instrument which differs from a single cut or float file only by having larger teeth. An inexperienced workman often makes his work fit too tight in one place, and too easy in another, hence the mortise is split by driving the parts together, and the work is never firm; whereas if the tenon fill the mortise equally, without using any considerable force in driving the work together, it is found to be firm and sound. The thickness of tenons should be about one-fourth of that of the framing, and the width of a tenon should never exceed about five times its thickness, otherwise, in wedging, the tenon will become bent, and bulge out the sides of the mortise. If the rail be wide, two mortises should be made, with a space of solid wood between; fig. 80 shows the tenons for a wide rail. If the tenon occurs at the end of a piece of framing, it must be set back a little, so as to allow sufficient solid wood to form a sound mortise; this is called a haunching (see *e*, fig. 81). In thick framing, the strength and firmness of the joint is much increased by putting a cross or feather tongue in on each side of the tenon;

FIG. 80.—Tenons for w de Railing.

these tongues are about an inch in depth, and are easily put in with a plough proper for such purposes. The projected figure of the end of a rail, as in fig. 80, shows these tongues put in; in the style there are grooves ploughed to receive them. Sometimes these projections are left in the solid wood itself, in which case they are called *stump tenons*. Sometimes, in thick framing, a double tenon in the thickness is made; but we give the preference to a single one, when tongues are put in the shoulders, as we have described; because a strong tenon is better than two weak ones, and there is less difficulty in fitting one than two. The panels of framing should be made to fill the grooves, so as not to rattle, and yet to allow the panels to shrink without splitting. When the mouldings are stuck on the framing, as is often the case in large stuff, it becomes necessary to find the lines to bring the angles together. In square framing, this is done simply by cutting *a b*, *c d*, as in fig. 81, at a mitre; but if the framing be oblique angle, it is done by scribing; the angle at *a b* being determined by the eye, *c d* is cut parallel to it. Where large projecting or bolection mouldings are used, the French have a very excellent way of framing (fig. 82), which it would be well to imitate in this country. Here C is the panel round which the moulding B is framed and mitred, the whole is then framed into A, which is a section both of the styles and rails.

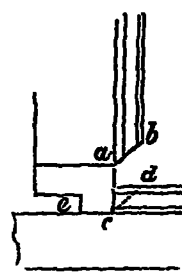


FIG. 81.—Fitting Mouldings to Framing.

When a frame consists of curved pieces they are often joined by means of pieces of hard wood called keys. Fig 83 is the head of a Gothic window frame joined with a key, with a plan of the joint below it. A cross tongue is put in on each side of the key, and the joint is tightened by means of the wedges, *a*, *a*. It is, however, a better method to join such pieces by means of a screw bolt instead of a key, the cross tongues being used whichever method is adopted. Where the ends of the bolts cannot be allowed to project, they should be fixed as *bed bolts*.

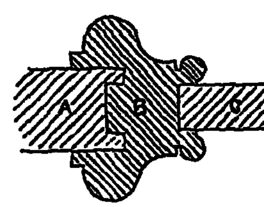


FIG. 82.—Bolection Mouldings.

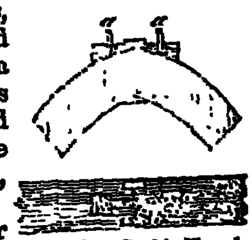


FIG. 83.—Gothic Keyed Frame.

Doors. *Doors* are made two and four panelled for the most part when the panels are flat and the framing square, six-panelled when the latter is moulded, and six, eight (as figs. 2 and 3, Plate XXVI., to which the details in the following description will apply), or even ten-panelled when the framing is of the superior descriptions. Doors which are hung in two equal widths to occupy the doorway, and are hung to the opposite side posts or jambs of the frame, are said to be folding-doors or double-margined,—that is, the styles or margins are repeated necessarily in the middle where they meet. The style, muntin, and rails to doors are the same as in framing or wainscoting; and the panels may be moulded in the same manner. Doorways are fitted with jamb linings, and architraves or pilasters. Jamb linings, as A in fig. 86, when they exceed 9 or 10 inches in width, should always be so framed to correspond with the door on the outer faces; or they may be made solid. Narrow and plain jamb linings to inferior rooms are rebated on one side of the lining only, and the rebate forms the frame into which the door is fitted. To superior work they are rebated on both sides, as if it were intended to put a door on each side. The jambs are fixed to the inner edges of the grounds, which are fixed to the wall to receive the architrave or other decorations to the opening, and to stop the plastering; if they are wide, and not framed, backings are put across to stiffen them; and these backings are dovetailed into the edges of the grounds.

It requires a considerable degree of care to hang a door, a shutter, or any other piece of work in the best manner. In the hinge, the pin should be perfectly straight, and truly cylindrical, and the parts accurately fitted together. The hinges should be placed so that their axes may be in Hanging doors.

the same straight line, as any defect in this respect will produce a considerable strain upon the hinges every time the hanging part is moved, will prevent it from moving freely, and is injurious to the hinges. In hanging doors, centres are often used instead of hinges; but, on account of the small quantity of friction in centres, a door moves too easily, so that a slight draught of air accelerates it so much in falling to, that it shakes the building, and is disagreeable. This may be in some degree remedied by placing a small spring to receive the shock of the door.

The greatest difficulty, in hanging doors, is to make them to clear a carpet, and be close at the bottom when shut. To do this, that part of the floor which is under the door when shut, or the width of the jambs, may have a piece of wood about a quarter of an inch thick above the general level of the floor, which, with placing the hinges so as to cause the door to rise as it opens, will be sufficient unless the carpet should be a very thick one. Several mechanical contrivances have been used for either raising the door, or adding a part to spring close to a floor as the door shuts. The best method now in use, and the simplest, is the invention of the rising or skew-butt hinge. The parts of this which bear on each other are made with a double bevel, so that, if more than half opened, the door falls against the wall by its own weight; if less than half open, it closes itself.

Various kinds of hinges are in use. Sometimes they are concealed, as in the kinds of joints called rule joints; others project, and are intended to let a door fold back over projecting mouldings, as on pulpit doors and outside folding shutters. When hinges project, the weight of the door acts with an increased leverage upon them, and they soon get out of order, unless they be strong and well fixed. The door of a room should be hung so that, in opening the door, the interior of the room cannot be seen through the joint. This may be done by making the joint according to fig. 84. The bead should be continued round the door, and a common butt-hinge answers for it

FIG. 84.—Door-Joint.

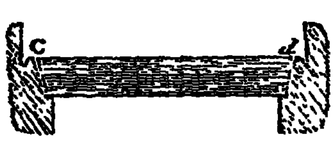


FIG. 85.—Bevel for Edge of Door.

The proper bevel for the edge of a door or sash may be found by drawing a line from the centre of motion C (fig. 85) to *e*, the interior angle of the rebate; *e d* drawn perpendicular to C *e* gives the bevel required. In practice the bevel is usually made less, leaving an open space in the joint when the door is shut; this is done on account of the interior angle of the rebate often being filled with paint.

The extension of the principle of ploughing and tonguing work together is one of the most important of the improvements that have been introduced by modern joiners. It is an easy, simple, and effectual method of combination, and one that provides against the greatest defect of timber-work, its shrinkage. By means of this method, the bold mouldings of mediæval architecture can be executed with a comparatively small quantity of material; and even in the mouldings of modern architecture it saves much labour. For example, the moulded part of an architrave may be joined with the plain part, as shown by fig. 86. If this method be compared with the old method of glueing one piece upon another, its advantage will be more evident.

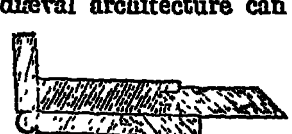


FIG. 86.—Joining of Architrave.

Architraves. Architraves and pilasters are variously sunk and moulded according to the fancy of the designer. They are fixed to the grounds with their internal edges exactly fitting to the rebates in the jambs, and they form the enriched margin or moulding of the frame in which the door is set. Architraves are mitred at the upper angle, but pilasters have generally a console or an enriched block or cap resting on them, to which they fit with a square joint; both the one and the other either run down and are scribed to the floor, or rest on squared blocks or bases, which may be the height of the skirting board, or of the whole base.

Fixing grounds. The architraves, skirtings, and surbase mouldings, are fixed to pieces of wood called *grounds*, as A, fig. 86; and as the straightness and accuracy of these mouldings depend upon the care that has been taken to fix the grounds truly, it will appear that fixing grounds, which is a part often left to inferior workmen, in reality requires skill and attention; besides, they are almost always the guide for the plasterer. Where the plasterer's work joins the grounds, they should have a small groove ploughed in the edge to form a key for the plaster. In old work the ground was generally hidden, but in modern work it is frequently shown, which is a saving of stuff; thus, instead of architraves being prepared

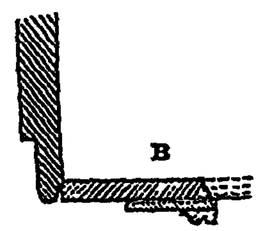


FIG. 87.—Door-Jamb and Ground.

FIG. 88.—Ground and Mouldings.

as in fig. 86, they are made as shown in fig. 87, where A is the rebated and beaded door-jamb, and B the ground, which is generally splayed at the back as a key to the plastering instead of being grooved. On this a thin piece of stuff is bradded to form the double-faced architrave, instead of sinking out of the solid, and on this the ogee or ovolo moulding is nailed. Again with base mouldings, A (fig. 88) is the ground fixed against the wall, on the top of which is nailed the upper moulding B, and C shows the skirting and lower moulding, fixed against a fillet on the floor.

Fixing joiner's work. We have thus far spoken chiefly of joinery as performed at the bench; but by far the most important part remains to be considered; for, however well a piece of work may have been prepared, if it be not properly fixed, it cannot fulfil its intended purpose. As in the preceding part, the general principles will be stated that ought to be made the basis of practice; and these illustrated by particular examples. When the carcass of a building is ready for the joiner, the first thing to be done is to cut the bond timber out of the openings, set the sash frames, and fill them with old sashes or with oiled paper on frames, to exclude the weather, but admit light. The flooring joists are then proved with straight-edges, and any inequalities in them are removed with the adze; the flooring boards are next cut down to their places, and are turned with their faces downwards until the ceilings are done. First, however, the pugging is done, if any be intended. This is to prevent sound passing through the floor when finished, and is sometimes called deafening sound-boarding. It is effected by nailing fillets to each side of the joists, near the bottom, and laying on these pieces of rough boards across

and close together; then there is put a layer of mortar mixed with chopped straw, or sometimes clay, sawdust, or small shells.

oring. The preparation given to flooring boards in superior work is planing the face, shooting the edges, and gauging to a thickness,—the common fillister or stop rebate plane being used to work down to the gauge mark, from the back of every board, and about half an inch in on each edge. When a board is to be laid, it is turned on its face in the place it is to occupy, and the workman with his adze cuts away from the back over every joist down to the gauge rebate, so that on being turned over it falls exactly into its place, and takes the same level with all its fellows, which have been brought to the same gauge; then follows the process of laying, and the result must, if the work be done well, be a perfectly even and level surface. The slight inequalities of surface which may occur are reduced with a smoothing-plane, the brads being previously punched below the surface if the floor be face-nailed. Floors are in ordinary cases either laid straight joint or folding, and are edge-nailed, as fig. 89, or face-nailed. According to the folding method, two boards are laid, their heading joints all on the same joist, and of course in the same straight line, and nailed at such a distance apart that the space is a little less than the aggregate width of the three, four, or five boards intended for it; these boards are then put to their places, and, on account of the narrowness of the space left for them, they rise like an arch between its abutments. The workmen force them down by jumping upon them. Accordingly, the boards are never soundly fixed to the joists, nor can the floor be laid with any kind of evenness or accuracy. This method should be avoided in all good work. Straight joint flooring is when every board is laid separately, or one at a time, the heading joint or joints being broken or covered regularly in every case. Dowelling is the driving-pins of wood or iron half their length, into the edge of the last laid board, the outer edge of which has been skew-nailed, their other ends running into holes prepared for them in the inner edge of the next board, in the way the head of a cask is held together, and then its outer edge is skew-nailed in the same manner, and so on. Tonguing is effected by grooving both edges of every board, and fitting thin slips and tongues into them. The boards are usually forced together by pressure as with a clamp applied to the outer edge. The nail used in face-nailing floors is called a flooring brad; it has no head, but a mere tongue projecting on one side of the top of the nail, which is put in the direction of the grain, that it may admit of being punched in below the surface level, otherwise the superficial inequalities could not be reduced when the floor was completed, because of the projecting heads of the nails. For side or edge nailing, however, clasp-nails, nails whose heads extend across on two of the opposite sides, are used.

As boards can seldom be got long enough to do without joints, it is usual, except in very inferior work, to join the ends with a tongued joint, as shown in fig. 89, where B

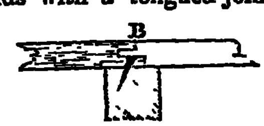


FIG. 89.—Tongued Joint.

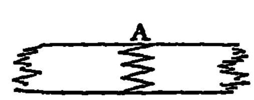


FIG. 90.—Forked Boards.

is the joint. The etched board is first laid, and edge-nailed to the joist. In oak floors the ends are forked together sometimes, as shown at A (fig. 90), in order to render the joints less conspicuous. The joints should be kept as distant from one another as possible.

In laying floors the advice of Evelyn only to tack the boards down the first year, and nail them down for good the next, is certainly the best method when it is convenient to adopt it; but, as this is very seldom the case, we must expect the joints to open more or less as the wood has been more or less seasoned. Now, these joints always admit a considerable current of cold air; and also, in an upper room, unless there be a counter floor, or pugging, the ceiling below may be spoiled by spilling water, or even by washing the floor. To avoid these disagreeable results, the boards should be ploughed and a tongue inserted into each joint, according to the old practice. When the boards are narrow, they might be laid without any appearance of nails, in the same way as a dowelled floor is laid, the tongue serving the same purpose as the dowels. In this case the cross or feather tongues for the joints should be used. A new system of flooring has for some years been used in London, to which the name of "Victoria floors" has been given. A rough floor of boards, three-quarters of an inch thick, is first laid, and the rest of the joiners' work fixed, and the plastering finished. When all is done, a floor formed of inch or inch and quarter plank, ripped down the middle, and consequently very little more than 5 inches wide, is laid; the rough boarding being first covered with a layer of shavings, or old newspapers, or other waste paper. These boards are dowelled on one edge and nailed on the other, and a very sound floor is thus formed, which neither springs nor creaks. A wainscot floor can be laid well on this principle.

Another early operation in joinery is the fixing of the framed grounds for the doors and windows, and for the skirting (Plate XXVI. fig. 5, and woodcuts, figs. 86, 87, and 88) to which the plasterers may float their work. The skirting grounds are generally dovetailed at the angles, and are well blocked out, so that they may not vibrate on being struck, or yield to pressure when the plasterer's straight-edge passes roughly over the surface; they must also be set with the utmost truth and precision. When the floors are cut down and the grounds fixed, the joiner's operations in a building should be suspended until the plasterers have finished, or nearly so, and then the floors may be laid. By deferring this operation until that period, the workmen of the two different trades are prevented from interrupting each other, and indeed injuring each other's work; and joiners always find employment in the shop preparing, as before intimated. Fixing frames

If the part to be fixed consists of boards jointed together, but not framed, it should be fixed so that it may shrink or swell without splitting or winding. The nature of the work will generally determine how this may be effected. Let us suppose that a plain back of a window is to be fixed. Fig. 91 is a section showing B the back of the window, A the window-sill, D the floor, C the skirting, and E the wall of the house. The back is supposed to be prepared as previously stated, and is kept straight by a dovetailed key *a*. Now, let the back be firmly nailed to the window-sill A, and let a narrow piece *d*, with a groove and cross tongue in its upper edge, be fixed to bond timbers or plugs in the wall, the tongue being inserted also into a corresponding groove in the lower edge of the back B. It is obvious, that the tongue being loose, the back B may contract or expand, as a panel in a frame.

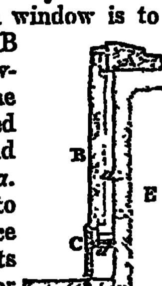


FIG. 91.—Back of a Window.

In getting out skirtings, if the work be of a superior description, the boards should be tried up as for framing in every way except bringing to a width, which need not be done. The face edges, however, must be worked with great precision, and moulded or rebated as the case may require. Rebating or tonguing will be perhaps necessary when the skirting consists of more than one piece, that the different Skirtings

pieces may be made to fit neatly and firmly together; and all but the lowest piece must of necessity be brought to a width, as well as tried up in other particulars. A skirting in a single width is called by that term; but when it is made up of more than one part it is designated a base; the lowest board is then called the skirting board, and the upper the base moulding or mouldings (Plate XXVI. figs. 1 and 5). The skirting board is not brought to a width because the labour would be lost according to the ordinary mode of fixing it. The board is applied to its place with its lower edge touching the floor; but as the most perfectly wrought floors are found to have some slight unevenness of surface so close to the wall, a straight edge would not fit closely down to it in every part. The board is therefore propped up at one end or the other until the upper or faced edge is perfectly parallel with the average line of the floor, or rather so as to be perfectly level. A pair of strong compasses, such as are used by the carpenter, is taken, and opened to the greatest distance the lower edge of the skirting board is from the floor throughout its length; the outer edge near the point of one leg of the compasses is then drawn along the floor, whilst the point of the other, being kept vertically above it, is pressed against the face of the board, on which it marks a line exactly parallel to the surface of the floor, indicating, of course, every, even the slightest, irregularity there may be in it. If the floor be not a very uneven one, the excluded part may be ripped off with the hand or the panel saw, which may generally be made to follow the traced or inscribed line exactly; if, however, the line be a very irregular one, having quick turns in it, the hatchet must be used. This operation is called *scribing*, and the result of it is evidently to make the skirting fit down on the floor with the utmost precision. Care must be taken in performing the operation that the upper edges of the skirtings be not only level, but that all which are in immediate connection be scribed to the same height, that their upper edges may exactly correspond.

In the principal rooms of a house, the skirting C (fig. 91) is usually grooved into the floor D, and fixed only to the narrow piece *d*, called a ground. (See also Plate XXVI. fig. 5.) By fixing in this manner, the skirting covers the joint, which would otherwise soon be open by the shrinking of the back, and from the skirting being grooved into the floor, but not fastened to it, there cannot be an open joint between the skirting and floor. When it is considered that an open joint in such a situation must become a receptacle for dust and a harbour for insects, the importance of adopting this method of fixing a skirting will be apparent. As grooving a floor is attended with considerable labour, and as the boards will sometimes twist, it is more common now to nail a small fillet to the floor, against which the back of the skirting rests, and, of course, has full room for expansion. Before skirtings are fixed, vertical blocks are put at short intervals, extending from the floor to the narrow grounds, and made exactly flush with and true to the latter, and are firmly nailed. These form a sound backing, to which the skirtings may be bradded or nailed, and so prevented from warping or bending in any manner. If, however, the skirting be not very wide, and be sufficiently stout to stand without a backing, a fillet only is nailed along the floor as a stop for its lower edge; but this is rendered unnecessary if the skirting be tongued into the floor, as the tongue will answer every purpose of a stop (fig. 5, Plate XXVI.) The ends of skirtings should be tongued into each other when it is necessary to piece them in length; and on returns or angles the end of one should be tongued into the returned face of the other in the square parts, and mitred in the oblique-angled or moulded parts.

The dado of a room should be fixed in the same manner as explained above for window backs (fig. 91). When a chair-rail or surbase is required, grounds similar to those for the base are fixed to range like them with the face of the plastering; the surbase itself must be wide enough to cover the grounds and the joints formed by them and the plastering completely; it is in effect a cornice to the stereobate (or pedestal, as the three parts may be termed of base, dado, and surbase), and the space or dado between it and the base is generally understood to be wainscoted, though it is more frequently plastered.

Fixing large boards.

In fixing any board above 5 or 6 inches wide, similar precautions are necessary as those detailed in fig. 91, otherwise it is certain to split when the house becomes inhabited. We may, in general, either fix one edge and groove the other, so as to leave it at liberty, or fix it in the middle and leave both edges at liberty. Sometimes a wide board, or a piece consisting of several boards, may be fixed by means of buttons screwed to the back, which turn into grooves in the framing, bearers, or joists, to which it is to be fixed. If any shrinking takes place the buttons slide in the grooves. In this manner the landings of stairs are fixed, and it is much the best mode of fixing the top of a table to its frame.

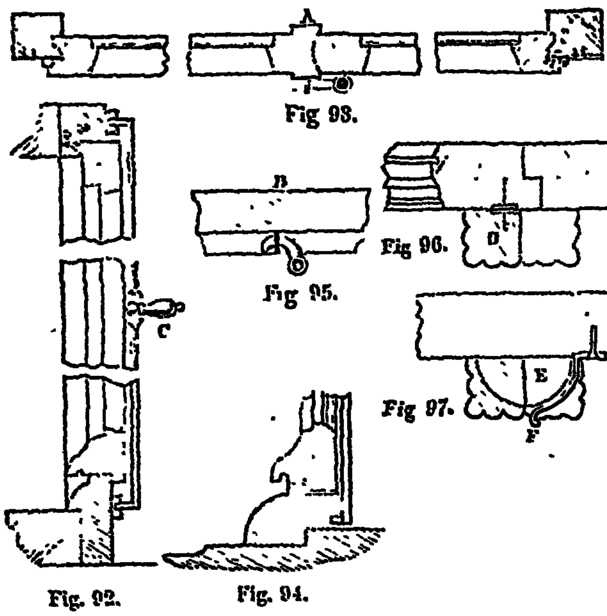
Sashes.

The parts of the outside frame of a sash are distinguished by the terms applied to the similar parts of common framing. The upright sides are styles, and the transverse or horizontal ones, which are tenoned into the ends of the styles, are rails; but the inner framework or divisions for the panes are called merely upright and cross bars (these bars, according to the way they are moulded, are called lamb's tongue, ovolo, beaded, &c.),—the upright being the mortised, and the cross bars the tenoned, as with the outer framework (Plate XXVI. fig. 1). Sashes are got out like common framing; the parts are tried up, set out, and mortised and tenoned, exactly in the same manner, allowance being made in the length of the rails and all tenoned pieces in the setting out, as in common framing also, for the portions of the mortised styles and upright bars which are worked away in forming the moulding and rebate. The meeting rails of sashes which are in pairs, to be hung with lines, are made thicker than the other parts by the thickness of the parting bead, and they are bevelled or splayed off, the one from above and the other from below, that they may meet and fit closely. When the framework is completed, although it cannot be put together because of what has just been referred to, the rebate is formed by the sash fillister on the further part of the face edge, and the moulding struck on its hither angle. These things being done, the moulded edges are either mitred or scribed at the shoulders and haunches, and the sash may be put together. If sash bars are mitred at the joints, they require dowels in the cross bars to act as tenons; but if they can be scribed, dowelling is not necessary. Sashes are either hung upon hinges or hung with lines, pulleys, and weights. Fixed sashes are put into frames, of which every part may be solid but the stop, which must be put in behind the sash to detain it. Sashes hung with hinges are usually called casements, and require solid rebated frames; but there can be no stops to them, except their own movable fastenings, and the outer stop, which of course the rebate furnishes.

French casements.

These are usually known as French casements, or sash doors, as they are called when they open down to the ground or floor; they have now taken the place of sash windows, where they may lead from the room to garden paving, or to a balcony, or may be used for similar purposes. The ordinary arrangement for an aperture is that of two leaves working on hinges at the sides inwards or outwards, meeting in the centre of the opening. With the former, which is the usual mode, one leaf is secured to the head and sill by bolts either round or sunk in; the other leaf, when closed, is secured to the first by a handle fixed on the second and turning over a staple fixed on the first. If the casement

should be a high one, this second leaf often requires a bolt at top and bottom, to secure it against the force of the wind, which by bending it admits the cold air and wet. When it is placed towards an exposed aspect, and is thus subject to driving rains, it is necessary to take many precautions for the prevention of wet being blown through the meeting surfaces all round the casements. To effect this object, the styles, rails, and frames are sunk and beaded in various ways. Figs. 92 and 93 represent sills and



FIGS. 92-97.—French Casement fittings.

bottom rails; and fig. 94, meeting rail, styles, and frame, which last is an ordinary arrangement in France. An improvement to the mere handle for securing the leaf of the casement is that of affixing an upright metal rod, which is turned by the handle C, fig. 92, on the leaf being closed, and by hooks at top and bottom as B, fig. 95, catching into a plate fixed for them, and effectually fastening it. A simpler method has been shown where, in lieu of the rod, a reeded bar, as D, fig 96, is moved to and fro as the leaf is required to be opened or shut, the top and bottom of the bar being rounded as shown at E, fig. 97, so as to slide into two segmental plates F, secured to the sill and lintel. Fig. 96 is a plan of the two casements, and 97 a plan of the head and sill. The metal rod, which is of brass, is called the Espagnolette bolt. Another mode of securing the casements has lately been introduced, whereby a flat plate, the whole height of the opening, is inserted in a groove formed in one edge of the meeting style of a leaf; and on this being closed the plate is shot forward by a handle into a groove in the other leaf, fastening the two together, the plate forming a stop against both the wind and the rain. This is a patent arrangement of Arch. Smith and Co. Fig. 98 is a plan of the usual French casement used at Paris. A shows the two leaves of the casement when shut; B is a plan of the shutters in their boxing, CC the shutters when closed, D the bolt, E the inside architrave and F the *Persiennes*, or outside blinds, shut against the stone reveals, and so provided for by the architect, instead of being an addition made by the upholsterer after the work is done, and perhaps spoiling the design. The ordinary mode is for them to be hung with projecting hinges to admit of their being folded back into the face of the wall, which is a hideous arrangement for any façade, except perhaps one of plain brickwork or plain cement. GG shows the position of the blinds when shut, and H is the outside architrave. Much difficulty arises in preventing the rain and wind from penetrating under such doors. The French raise the doors very much to secure this, as shown in figs. 92 and 94. In England various methods have been adopted by forming second sills of metal cast into shapes to form gutters and throats; perhaps the best arrangement is the "patent sill or water bar" (fig. 99), as now manufactured by Archibald Smith and Co. A metal plate A is screwed to the face of the bottom rail. An arrangement in metal B is screwed to the upper weathering of the wood sill C, having on its outer edge a plate D hinged to it. When the door is opened this plate falls down, and when the door or leaf is shut, a pin E, let into the underside of the bottom rail, forces up the hinged plate D, and presses it against the first named plate A, making all tight. Fig. 100 is a section of a mediæval moulded bottom rail found in France. When the window lights are carried up over the casements, as is very often the case, the upper lights are generally fixed; but it is better that one or two of them should be rendered available for ventilating the apartment when it is not desirable to have the door itself open. This will be effected by hinging the light on the bottom rail, with the necessary means of opening and closing it, or placing it on centre hinges at the sides.

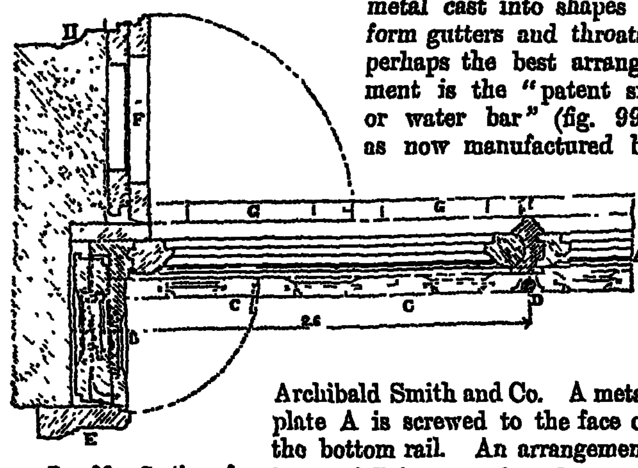


FIG. 98.—Section of French Window.

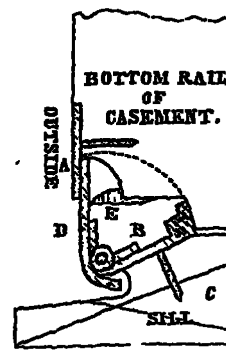


FIG. 99.—Water Bar.

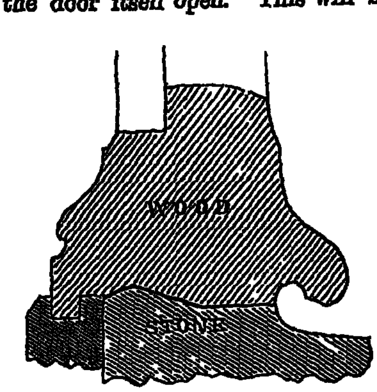


FIG. 100.—Ancient French Bottom Rail.

Sashes hung with lines require cased frames (Plate XXVI. figs. 1, 4), to receive the pulleys and weights. The sill of the frame is made, as in the former cases, solid, is sunk and weathered, and is generally made of a more durable material than the rest of the frame; the sides in the direction of the thickness of the frame are of one and a quarter or one and a half inch board, very truly tried up, and grooved to receive a parting bead; for it must be obvious that sashes hung with lines to run vertically up and down within the height of the frame must be themselves in two heights, and must pass each other in separate and distinct channels. The ends of these boards are fixed into the upper face of the solid sill below, and into a similar board parallel to the sill which forms a head above, and they are called pulley pieces, or styles, because they receive the pulleys, which are let into them near their upper ends.

Linings from 4 to 6 inches in width, and from three-fourths of an inch to an inch in thickness, are nailed on to the edges of the pulley pieces, and to the sill and head above and below, inside and outside, in the direction of the breadth of the sash frame, and are returned along the head in the direction of its length. The outside linings are made to extend within the pulley pieces about half an inch, to form a stop for the upper and outer sash; and the inside linings are made exactly flush with their inner faces. The casing is completed by fixing thin linings on the outer edges of the outside and inside linings, parallel to the pulley pieces, to prevent anything from impeding the weights. Thin slips called parting-beads are fitted tightly into the grooves previously noticed in the pulley pieces, but they are not fixed, as the upper sash can be put in or taken out only by the temporary removal of the parting-bead. An inner or stop bead is mitred round on the inside to complete the groove or channel for the lower sash; the stop bead covers the edge of the inside linings on the sides and head, and is fixed by means of screws, which may be removed without violence when it is required to put in or take out the sashes. A hole covered with a movable piece large enough to allow the lead or iron weight to pass in and out, is made in each of the pulley pieces, so that the sashes may be hung after the frames are set, and to repair any accident that may occur to the hangings in after use (Plate XXVI. fig. 4). It may be remarked that sash frames require greater truth and precision from the workman than anything else in the joiners' work of a building; and unless the stuff employed be quite sound and perfectly seasoned all the workman's care will be thrown away.

Sashes, it may be remarked, are never fitted until these frames are immovably fixed, so that if there be any inaccuracy in the latter, the sashes are cut away or pieced out to make them fit; but, as they are intended to traverse, the fitting in that case can only apply to one particular position, and in every one but that there must be something wrong. Any incorrectness in the sash-frame, again, must throw the shutters and their back flaps out; indeed, the sash-frame, though apparently a secondary part of the arrangement, is that which affects all the rest beyond anything else. When sashes have been fitted, a plough groove, wide and deep enough to receive the sash-line, is made in the outer edges of the styles, for about two-thirds of their length, at their upper ends. They are then primed and glazed, and when the putty is sufficiently set the joiner hangs them. He is furnished with sash-line, which is made of the best flax well plaited together, tacks, and iron or lead weights, which are generally made cylindrical, with a ring at one end, to which the line may be attached. A sash is weighed, and two weights are selected which together amount to within a few ounces of a counterpoise. The line is then passed through the pulley, which was previously fixed in the pulley style; the end is knotted to a weight which is passed in at the hole left for the purpose; and at a sufficient distance, which a common degree of intelligence will readily determine, the line is cut off and the end tacked into the groove in the style of the sash. Other modes of attaching the sash-line to the sash are also used.

Of recent inventions connected with windows there are some for enabling the parting-beads to be taken out, or are dispensed with, so that sashes may be readily cleaned without the operator standing on the sill, a dangerous practice, and without the use of the glazier's horse, which tends to injure the inside painting. A contrivance for easily opening and closing sashes of large size by an arrangement of cords and pulleys, which likewise secure it when shut, is patented by Mr Meakin. Another, having counterbalancing rack slips for hanging sashes, dispenses with the use of sash lines, pulleys, and sash weights. An objection to this invention may be that both upper and lower sashes must be opened at the same time. There are other useful arrangements for opening windows, such as those used in the wards of hospitals, where the opening is divided into about four horizontal lights working on pivots, all opening to any required extent by a rack and pinion. A sash fastener with a second spring, which clips the projection on the lower sash when the fastening is closed, and another where the shape of the arm of the fastener is altered, both prevent the sash being opened from without by a knife, a common mode of forcing an entrance into buildings. Patent wrought windows, and patent wrought iron water-tight windows and frames suitable for churches, parsonage houses, &c., are readily obtainable.

Window fittings.

The fittings of a window which has boxed shutters consist of back linings, grounds, back elbows and soffit, together with shutters and back flaps, and architraves (or pilasters) round on the inside to form a moulded frame (figs. 1 and 4, Plate XXVI.) Back linings are generally framed with flush panels; they fit in between the inside lining of the sash frame and the framed ground, to both of which they are attached, and form the back of the boxing into which the shutters fall back. They are tongued into the inside lining by their inner edge, and on the outer edge the ground is nailed, and they are set at right angles to the sash-frame, or obtusely outwards, as the shutters may be splayed or not. The back is the continuation of the window fittings from the sash-sill to the floor on the inside; the elbows are its returns on both sides under the shutters, and the soffit is the piece of framing which extends from one side of the window to the other across the head, or from back lining to back lining. These are all framed to correspond with the shutters on the face; but, as they are fixed, their backs are left unwrought. Window shutters are framed in correspondence with the door and other framed work of the room to which they belong, in front, and generally with a flush panel behind; the back-flaps are in one or two separate breadths to each shutter, according to the width of the window and the depth of the recess; they are made lighter than the shutters themselves, and they should, when shut to, present faces exactly corresponding with those of the shutters, both internally and externally. The shutters are hung to the sash-frame with butt hinges, and the back flaps are hung to their outer styles with a hinge called a back-flap, from its use. The shutters and their back flaps are hung in one, two, or more heights, as may be found convenient. The moulded margin round the boxings of a window on the inner face are made to harmonize generally with the similar parts of the doors of the room or place to which it belongs. See other examples of shutters and their boxing in fig. 98. The fixing and hanging of window fittings or dressings are hardly less important, for the accuracy required, than the making and fixing of the sash-frame itself; the slightest infirmity or inaccuracy in any part will be likely to derange some essential operation.

Shutters.

Rolling shutters.

To this old manner of forming shutters must be added the rolling shutters of Clark, Bunnett, Francis, Snoxell, and others. These can be fixed either at the top, bottom, or side of the window as convenient, and are made of wood, steel, iron, or of wood and iron, many of them requiring machinery to raise and to lower them. The advantages consist in the small space occupied, the great security obtained, and the rapidity and ease in opening and shutting them. They are, however, apt to stick, and some are noisy, but one is called the "noiseless self-coiling revolving steel shutter." One variety consists in a sheet of well-tempered corrugated steel, which coils up on itself like a roll of paper; another is a self-acting wood revolving shutter, with hardened steel bands.

Stairs. The construction of stairs is generally considered the highest department of the art of joinery. The principal object to be attended to is that the stairs should afford a safe and easy communication between floors at different levels. The strength of a stair ought to be apparent as well as real, in order that those who ascend it may feel conscious of safety. To make the communication safe, it should be guarded by a railing of proper height and strength; in order that it may be easy, the rise and width (or tread) of the steps should be regular and justly proportioned to each other, with convenient landings; there should be no winding steps, and the top of the rail should be of a convenient height for the hand. The first person that attempted to fix the relation between the height and width of a step, upon correct principles, was, we believe, Blondel, in his *Cours d'Architecture*. His formula is applicable to very large buildings, but not to ordinary dwellings. Mr Ashpitel, who investigated the subject at length, gives the following rules for buildings of seven different classes:—

Tread breadth in inches.	Rise height in inches.	Tread breadth in inches.	Rise height in inches.
12	5½	10	6½
11½	5¾	9½	6¾
11	6	9	7
10½	6¼		

These dimensions give angles of ascent varying from 24° to 37°. Of course the projection of the nosing is not reckoned.

Hawksley's patent treads for staircases to public thoroughfares are composed of iron frames, in which small blocks of wood, placed the end way of the grain, are so secured as to present to the foot a roughened surface. They appear to be durable, and to admit of easy renewal of the wood when worn or injured.

The forms of staircases are various, commencing with a straight flight, which should only be used to a low story. In towns, where space cannot be allowed for convenient forms, they are often made triangular, circular, or elliptical, with winding steps, or are made of a mixed form, with straight sides and circular ends. In large mansions, and in other situations where convenience and beauty are the chief objects of attention, winding steps are never introduced when it is possible to avoid them. Good stairs, therefore, require less geometrical skill than those of an inferior character. The best architectural effect is produced by rectangular staircases, with ornamented railing and newels. In Gothic structures scarcely any other kind can be adopted with propriety for a principal staircase. Modern architecture admits of greater latitude in this respect,—the end of the staircase being sometimes circular, and the hand-rail continued, beginning from either a scroll or a newel.

When a rectangular staircase has a continued rail, it is necessary that it should be curved so as to change gradually from a level to an inclined direction. This curvature is called the *ramp* of the rail. The plan of a staircase of this kind is represented by ABCD in fig. 101; and fig. 103 shows a section of it, supposing it to be cut through at *a b*, on the plan. The hand-rail is supposed to begin with a newel at the bottom, and the form of the cap of the newel ought to be determined so that it will mitre with the hand-rail. Let H in fig. 102 be the section of the hand-rail, and *a b* the radius of the newel; then the form of the cap may be traced at C. The sections of hand-rails are of various shapes; some of the most common ones are too small; a hand-rail should never be less than would require a square of which the side is 2½ inches to circumscribe it. For the level landings of a staircase the height of the top of the hand-rail should never be more than about 40 inches, and in any part of the inclined rail the height of its upper side above the middle of the width of the step should be 40 inches less the rise of one step when measured in a vertical direction. To describe the ramps, let *r s* in fig. 103 be a vertical line drawn through the middle of the width of the step; set *r u* equal to *r s*, and draw *u t* at right angles with the back of the rail, cutting the horizontal line *s t* in *t*; then from the point *t*, as a centre, describe the curve of the rail. When there is a contrary flexure, as in the case before us, the method of describing the lesser curve is the same.

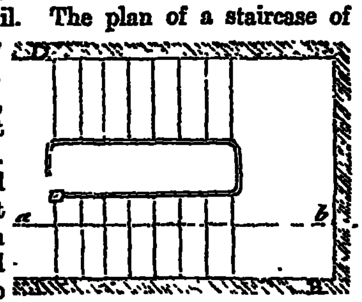


Fig. 101.—Plan of Rectangular Staircase.

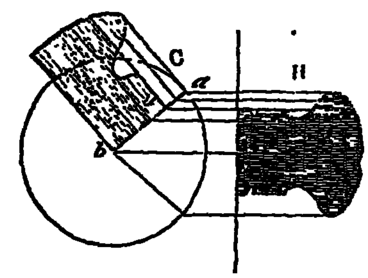


Fig. 102.—Section of Hand-Rail and Newel.

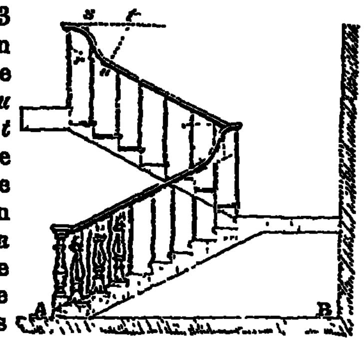


Fig. 103.—Section for Construction of Ramps.

The hand-rail of a stair generally begins with a scroll, and the first step of the stair is generally finished with what is called a curtail, a form corresponding closely to the scroll. There are a great variety of geometrical spirals; but as they all finish on a point, and as all architectural scrolls and volutes finish on a circle or eye, the usual mathematical scrolls are inapplicable. The earliest spiral adapted to architecture was that of De Lorme. Since his time several systems have been invented, particularly that of Goldmann; the best is that derived from the Ionic volute (fig. 104).

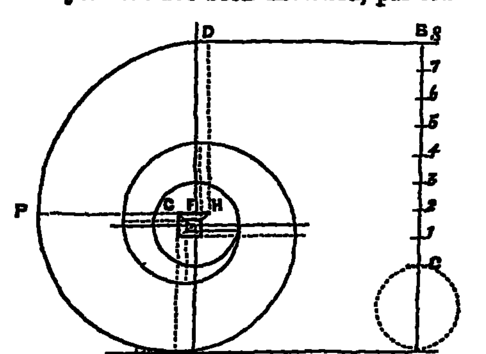


Fig. 104.

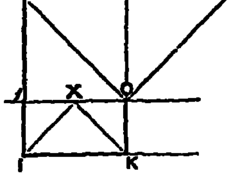


Fig. 105.

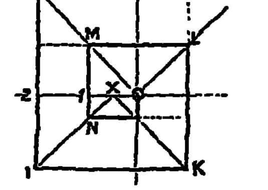


Fig. 106.

Figs. 104 to 106 illustrate the construction of the Ionic Volute.

The height, eye, and number of revolutions of the

spiral being given to describe the curve, let AB be the total height, and AC the intended height of the eye, and let the spiral be required to make two revolutions. Divide BC into four times as many parts as there are revolutions required ($4 \times 2 = 8$), because there are four quadrants in every revolution. Draw any line DE equal to the height of the spiral. Set down from D half the number of the parts and one more ($4 + 1 = 5$); this is the top of the eye. Set down half AC at O, and describe the eye; then at O set up half a part to F, and make FG, FH = OF; then, as in fig 105, draw OG, OH, GI, and from O draw a line parallel to GH, and divide the same into as many parts as there are to be revolutions. Fig. 105 is for one, and fig. 106 for two revolutions. Bisect O1 at X; make 2I = 2X, and join XI; and through 1 draw MN parallel to OF to meet OG and XI. Draw the quarter circles, as in the diagram,—HD being the first opening of the compasses, GP the next, and H, G, I, K, L, M, and N being the centres. To describe the scroll let AB, as in fig. 107, be the width across, usually about 10 or 12 inches; let EB be the intended diameter of the eye; and let the scroll be required to make one revolution and a half, or six quadrants (these are shown at greater size by the side of fig. 108), then proceed as last directed, and complete the scroll, also dot in the lines of the nosings and risers. For the curtail step transfer the lines of nosings *a*, and the lines of the risers *b*, to another place, as in fig. 108, and set out the thickness of the veneer within the line of nosing, the part within this represents the solid block of the curtail. The places of the balusters are shown in fig. 107.

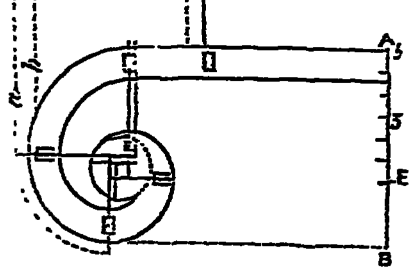


Fig. 107.

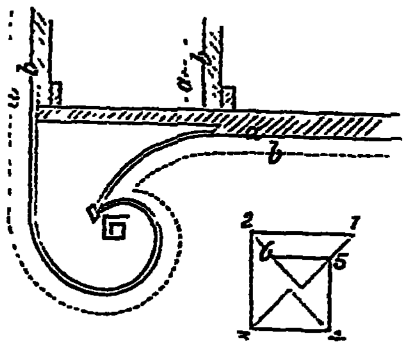


Fig. 108.

Figs. 107, 108 illustrate the formation of Scroll and Curtail Step.

It is obvious that in every geometrical staircase, the half of a cylinder placed upright in the well-hole would touch the wreathed string in all parts, another a little less would touch all parts of the hand-rail. Let us suppose ACB, as in fig. 109, to be the plan of half a cylinder so set upright in the well-hole, and let us suppose A'E to be the height of the same. Divide the curved line ACB into any convenient number of parts, and set the same off by compasses on the straight line from C to A' and C to B'. Or, in case ACB is a semicircle, divide the line AB, draw the diameter CD, making aD equal to three-fourths of the radius, and draw DA, DB, and the rest of the lines through the points of division, as shown in the diagram. Then A'B' is the stretch out or length of the circumference ACB unrolled. But A'E is said to be the whole height. From E set down the respective heights of the winders, step by step, as shown. Now let G be the representation of the cylinder, with the different lines squared up and across, these will give a representation of the curve at which the winders must ascend, and which, of course, must regulate the hand-rail. The other faint lines show the edge of the covering.

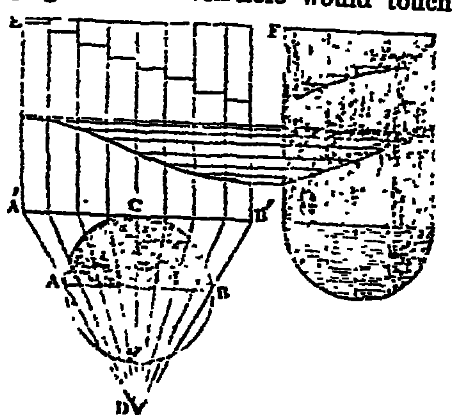


Fig. 109.—Construction of Hand-Rail.

Fig. 112 represents the plan of a staircase, beginning with a scroll, and having steps winding round the circular part of the well-hole. In the first place, let the end of the steps be developed according to the method we have just given (fig. 110 shows this development). Now the hand-rail ought to follow the inclination of a line drawn to touch the nosings of the steps, except where there is an abrupt transition from the rake of the winding to that of the other steps; at such places it must be curved,—the curve may be drawn by the help of intersecting lines, as in fig. 111. The part which is shaded in fig. 109 represents the hand-rail and ends of the steps when spread out, and the hand-rail is only drawn close to the steps for convenience, as it would require too much space to raise it to its proper position. This development of the rail is called the falling-mould. We will now refer to fig. 113, and will suppose the inner semicircle of ACB to be the plan of the well-hole, and *e*A, *a*B, the width of the rail; then the outer shaded part ACB will be the plan of the rail on the level; ADEB is the cylinder referred to before—ADE being the angle at which the stairs ascend. Now since by the principles of Conic Sections the oblique section of a circular cylinder is an ellipse, if the cylinder be circular the lines may then be found by a trammel. Be it of what section it may, the delineation of a cylinder cut at any angle ADE may be found by dividing it into equal parts, and setting up the ordinates *a*1, *b*2, &c., as shown. This delineation is a plan "on the oblique," or the face-mould of the rail, to be cut "on the plumb."

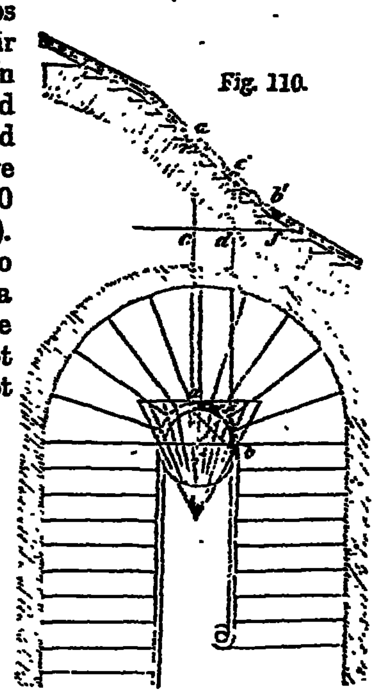


Fig. 110.

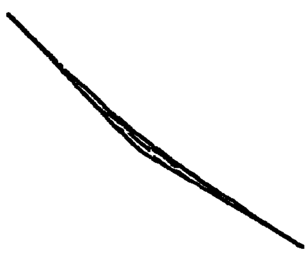


Fig. 111.

Fig. 112.

Figs. 110–112.—Development of Circular Hand-Rail.

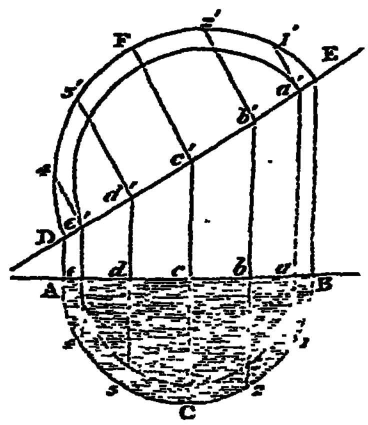


Fig. 113.—Tracing the Face-Mould of Rail.

The wood used for hand-rails being of an expensive kind, it becomes of some importance to consider how the plank may be cut so as to require the least quantity of material for the curved part of the rail. Now, if we were

to suppose the rail executed, and a plain board laid upon the upper side of it, the board would touch the rail at three points; and a plank laid in the same position as the board would be that out of which the rail could be cut with the least waste of material. Let it be required to find the moulds for the part $a\,b$ of the rail in fig. 112, and to avoid confusing the lines in the small figure, the part $a\,b$ has been drawn to a larger scale in fig. 114. The plain board mentioned above would touch the rail at the points marked C and B in the plan; draw the line CB, and draw a line parallel to CB, so as to touch the curve at the point E. Then E is the other point on the plan; and a', c', and b', are the heights of these points in the development in fig. 110. Erect perpendiculars to CB, from the points C, E, and B (fig. 114), and set off Ca' in fig. 114 equal to $a'c$ in fig. 110, Ec' equal to $d\,c'$, and Bb' equal to $f\,b'$. Through the points C and E, draw the dotted line Ch; through a', c', draw a line to meet CE in h; and through the points a', b', draw a line to meet CB in g; then join $h\,g$, and make Ci perpendicular to $h\,g$. Now, if Cd be equal to Ca, and perpendicular to Ci, and $d\,i$ be joined, it will be the angle which the plank makes with the horizontal plane, or plan. Therefore, draw FD parallel to Ci, and thence find the section, which is the same thing as would be obtained by projecting vertical lines from each point in the hand-rail against the surface of a board laid to touch it in three points. The inexperienced workman will be much assisted in applying the moulds if he acquires a clear notion of the position when executed.

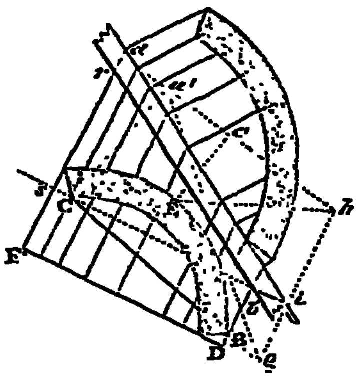


FIG. 114.—Illustrating the Tracing of Moulds.

To find the thickness of the plank, take the height to the under side of the rail $c\,r$ in the development (fig. 110), and set it off from s, in the line Ci, to r, in fig. 114; from the point r draw a line parallel to $d\,i$, and the distance between those parallel lines will be the thickness of the plank. The mould (fig. 114), which is traced from the plan, is called the *face mould*. It is applied to the upper surface of the plank, which being marked, a bevel should be set to the angle $i\,d$ C, and this bevel being applied to the edge will give the points to which the mould must be placed to mark out the under side. It is then to be sawn out, and wrought true to the mould. In applying the bevel, care should be taken to let its stock be parallel to the line $d\,i$, if the plank should not be sufficiently wide for $d\,i$ to be its arris. In the method fig. 113, ADE, on the rise of the stair, is the bevel. After the rail is truly wrought to the face-mould, the falling-mould (fig. 110), being applied to its convex side, will give the edge of the upper surface and the surface itself will be formed by squaring from the convex side, holding the stock of the square always so that it would be vertical if the rail were in its proper situation. The lower surface is to be parallel to the upper one. The sudden change of the width of the ends of the steps causes the soffit line to have a broken or irregular appearance; to avoid this, the steps are made to begin to wind before the curved part begins. Different methods of proportioning the ends of the steps are given by Nicholson, Roubo, Rondelet, and Krafft. We cannot in this place enter into a detail of these methods, nor can we give the varied systems of cutting the rail in the spring and in the plumb, about which so much has been written, but for the reader's information a list of the principal writers on *Staircases and Hand-Railing* is subjoined.

Nothing appears to have been written on joinery until Joseph Moxon, a fellow of the Royal Society, published a work entitled *Mechanick Exercises, or the Doctrine of Handyworks*, 4to, 1677. The introduction of the geometrical staircase, or stair supported on one side by the wall, invented, says Palladio, by the famous Luigi Cornaro (the first English example of which is said to be that erected in stone by Sir Christopher Wren in St Paul's Cathedral), led to the greatest changes in the art of joinery, inasmuch as the lines for setting them out necessitated a very considerable knowledge of geometry. The hand-rails of these stairs offered most difficulties, and an imperfect attempt to remove them was first made by Halfpenny, in his *Art of Sound Building*, published in 1725. Price, the author of the *British Carpenter*, published in 1733-35, was more successful, and his remarks show a considerable degree of knowledge of the true nature and object of his researches. The publication of this book must have produced a considerable sensation in the trade, for it was soon followed by many other works of different degrees of merit. Of these the publications of Langley and of Pain were the most popular, and were followed by Roubo, *L'Art de Menuisier*, folio, 1771; Skaife, *Key to Civil Architecture*, 8vo, 1774; *Transactions of the Society of Arts*, &c., for 1814; *Treatise on the Construction of Staircases and Hand-Rails*, 4to, 1820; Rondelet, *Traité de l'Art de bâtir*, tom. iv. 4to, 1814; Krafft, *Traité sur l'Art de la Charpentier*, part ii., folio, 1820; Jeakes, *Orthogonal System of Hand-Railing*, 1849; Ashpitel, *On Hand-Rails and Staircases*, 4to, 1851; Galpin, *Joiner's Instructor, Staircasing and Hand-Railing*, 4to, 1853; and Riddell, *Hand-Railing Simplified*, folio, Philadelphia, 1856 and 1860. Bibliography

The establishment of the principles of joinery on the sound basis of geometrical science was reserved for Nicholson. In his *Carpenter's New Guide* and *Carpenter and Joiner's Assistant*, published in 1792, 4to, he has made some most valuable corrections and additions to the labours of his predecessors. This writer has been the founder of all the subsequent works on the subject; his books have been published again and again, in various forms, with additions from time to time, by different hands, as Galpin's *Joiner's Own Book, showing Improvements since the Days of the late Mr Nicholson*, 4to, 1856. Corresponding improvements were also made in the practice of joinery, for which we are much indebted to an architect, Mr James Wyatt.

For revived mediæval and Elizabethan joinery, particularly as adapted to windows and staircases, see Weale's *Carpentry*, 4to, 1849, and Shaw, *Details of Elizabethan Architecture*, 4to, 1839. Many modern improvements are given in Laxton's *Examples of Building Construction*, fol., 1855-58, and in Newland's *Carpenter and Joiner's Assistant*, fol., Liverpool, 1860.

The principles of joinery were cultivated in France by a very different class of writers. The celebrated Blondel, an architect of great eminence, had given details for the construction of shutters, wainscoting, doors, hinges, fastenings, &c., in his work *Distribution des Maisons de Plaisance*, 4to, 1737-38. In the extensive work of Frezier, entitled *Coupé des Pierres et des Bois*, 3 vols. 4to, 1739, all the leading principles are given and explained with tedious minuteness, offering a striking contrast to the brevity of English writers. The first elementary work on that part of geometrical science which contains the principles of joinery appeared in France in 1705, from the pen of the celebrated Gaspard Monge, who gave it the name of *Géométrie Descriptive*. The most celebrated French work which treats of joinery is Rondelet's *L'Art de bâtir*, which occupied fourteen years (from 1802 to 1816) in publication. It is also the best foreign work on the subject; but it is little adapted to the state of joinery in England. In practice the French joiners are very much inferior to the English workmen. Their work is rough, slovenly, and often clumsy, and at the best is confined to external effect. The neatness, soundness, and accuracy, which is common to every part of the works of an English joiner, is scarcely to be found in any part of the works of a French one. The little correspondence, in point of excellence, between their theory and practice leads us to think that their theoretical knowledge is confined to architects, engineers, &c., instead of being diffused among workmen, as it is in England. See also Thiollet et Roux, *Nouveau Recueil de Menuiserie*, 1837; Viollet-le-Duc, *Dict. Raisonné du Mobilier Français*, 8vo, 1858, &c.; and Nosban, *Manuel de Menuiserie*, 4to, 1849. Much also may be learned from Emy, *Traité de la Charpente*, fol., 1847—particularly with regard to framing. The publications of other nations do not call for particular notice.

CABINET-MAKING.

Cabinet-making, or that part of the art of working in wood which is applied to furniture, has some affinity with joinery, the same materials and tools being employed in

Laying slates.

which is employed in plain tiling. To a roof with projecting eaves a wide board is placed over the ends of the rafters; but when the eaves tail into gutters, the gutter-board is made wide enough to receive the eaves-course For light slating it is necessary to board a roof all over with three-quarter inch rough boarding. This is done by the carpenter; but for strong heavy slates, fillets or laths or battens are considered sufficient; and these are laid by the slater himself, to suit the length of his slates. Three inches wide and one inch thick is a sufficient size for them, if the rafters be not more than 12 inches apart. Against gable or party-walls, a feather-edged board called a tilting fillet is laid to turn the water from the wall. A preferable plan, however, is to board all roofs; it gives a better bed for the slates, and fewer are broken if there be occasion for workmen to walk over them in repairing or in cleaning out the gutters. The expense, too, is but trifling beyond that of the laths. A still further benefit is obtained by bedding the slates in mortar or in hay, which fills up the spaces left by the thickness of the first slate, and with the boarding tends to keep the roof cooler in summer and warmer in winter, a very desirable result for the habitable rooms close under them. Where the roofs are finished with diagonal boarding on purlins without rafters, it makes a very sound bedding for slates. All the slates being gauged to a width, and dressed as above described, and sorted in lengths, they are then taken up to the roof in rotation, beginning with the longest and largest for the lowest courses. The first course the slater lays is little more than half the length of that which is intended to cover it, and is necessary to break the joints at the eaves. This is called the doubling eaves-course; and the covering eaves-course is brought to the same foot line, completely to cover it. Then to ascertain the gauge:—from the length of the slate deduct the bond, which should never be less than 2 inches, and need not be more than 3½ inches, and the half of what remains will be the gauge. Thus, if the bond be fixed at 3 inches, and the slate is 2 feet 3 inches in length, the gauge will be 1 foot. This gauge or margin is set up from the foot of the eaves-course at each end, and a line strained to mark it along the whole length, and so on, to the ridge or top, where another half-course is required to complete the work, and that is in its turn secured by a covering of sheet lead with a roll. To a hipped roof care is taken to complete every course up to the angle, by cutting slates to fit its slope; and these are also covered by an overlap of sheet lead with a roll, it being nailed or screwed to the hip rafter, and the head bossed over. Slate ridging with a roll, as fig. 115, or with a groove for receiving an ornamented cresting, is now very usual, and even a common ridge tiling is necessary to prevent theft of the lead in some localities. Fig. 116 shows specimens of the ornamental red ridging tiles occasionally used, continuously or some lengths of a plain tile apart. In fig. 115, A, A are the two portions of the slate roll ridging, B being the roll with a hole drilled at each end for the insertion of a pin to fix the lengths; C the ridge piece fixed in the head of the king-post D; E the rafter; F the lath on which G, the slating, is nailed. In nailing a slate, it must not be strained or bent in the slightest degree, or it will certainly fly in some sudden atmospheric change, to which it is of course constantly liable, even if it escape fracture from being trodden on by the workmen themselves or by others. Copper, being less liable to oxidize from exposure to common causes than any other metal that will answer the purpose, should always be used for slate nails. Zinc is also occasionally used; and iron tinned and painted nails are sometimes substituted by dishonesty on the part of the workman or builder, or bad economy on that of the proprietor. The French method of fixing slates by means of wire clips which hold the bottom of the slates is unusual in England. A method has lately been introduced of effecting it with lead clips, which is said to dispense with a certain proportion of slates. Each slate is held in something of the same manner which the slater now adopts when a broken slate has to be replaced, and the main advantage is supposed to be that the slates are firmer.

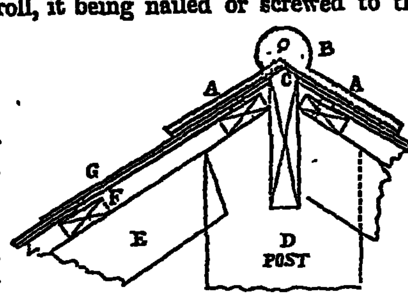


FIG. 115.—*Ridge of Roof.*

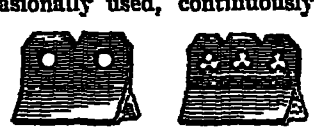


FIG. 116.—*Ridging Tiles.*

The mode above described of ascertaining the gauge or margin by the bond, is equally applicable to every sort of roof-covering that is made up of small inflexible parallelogramic slabs or tablets; and it should be borne in mind that the greater the angle is at which the rafters rise, or, in technical language, the higher the pitch of the roof, the less the bond may be, and *vice versa.* With slabs or tablets that vary in length, too, as slates generally do as they are brought to market, it is the bond which it is of importance to observe; but if they are of an invariable length, as tiles are, it is sufficient that the gauge or margin be attended to.

Patent slating.

A very light and neat covering is produced by laying wide slates side by side, and covering their joints with narrow slips bedded in putty, the overlap at the ends being no more than the bond is with the usual mode. It is known as patent slating, and was introduced by Mr Wyatt, who never, however, obtained a patent for it. Indeed it is in principle the mode which was adopted in ancient Greece in covering the roofs of temples. Neither boards nor fillets are used, the slates bearing from rafter to rafter, which may be 2 feet or more apart, and to the rafters the slates are screwed. The covering slips are also screwed, as well as bedded in putty. Slating of this kind may be laid at no greater elevation than 10°, whereas for slating in the ordinary way the angle should never be much less than 25°, though large slates with a 3½ inch bond, carefully laid and pointed, may perhaps be trusted at a rise of 20°. This mode of applying slate is not without the disadvantage attending the fixing of any substance that freely takes up and readily parts with heat. In expanding and contracting, the joints are too often destroyed, and leaks are the common consequence.

Thatching.

Thatching is an admirable covering for securing warmth in winter and coolness in summer; but it is subject to injury by birds, and to risk from fire. It is still occasionally used in picturesque cottages, arbours, and similar buildings, and was much used for churches in Norfolk and Suffolk. The thatcher requires a common stable fork, to toss up the straw together before being made into bundles; a thatcher's fork, to carry the straw from the heap up to the roof; a thatcher's rake, to comb down the straw straight and smooth; a knife, or eaves knife, to cut and trim the straw to a straight line; a knife, to point the twigs; a half glove of leather, to protect the hand when driving in the smaller twigs or spars; a long flat needle; a pair of leather gaiters to come up above the knees, used when kneeling on the rafters; and a gritstone to sharpen the knives. Wheat straw lasts from 15 to 20 years, and oat straw about 8 years. Reed thatching, as done in the West

of England, is the truss after the ears have been cut off, leaving the clean, sound pipe straw, of which a thickness of 3 inches is laid on the common thatching with spars only. The materials required are straw or reeds, laths, nails, withes, and rods. A load of straw, laid on about 12 to 16 inches in thickness, will do a square and a half; a bundle of oak laths, $1\frac{1}{4}$ inches wide, and from $\frac{1}{4}$ to $\frac{3}{8}$ths thick, nailed about 8 inches apart, 1 square; a hundred of withes, 3 squares; a pound of rope yarn, 1 square; a hundred of rods, 3 squares; and $2\frac{1}{2}$ hundred of nails, 1 square. Probably thatched roofs were formerly ornamented by a species of cresting, for in some parts of the country the withes or willow twigs that bind the thatch are sometimes arranged on the tops of ricks and cottages in an interlacing manner, terminating at the apex or at each end with a spike with a rudely formed cock. Viollet-le-Duc, in his *Dictionnaire*, alludes to the custom of forming the ridge in mud, in which plants and grasses were inserted to prevent the earth being dissolved and washed away by the rain.

Plumber-work.

Lead, as the name imports, is the material in and with which the plumber works. The principal operations of this trade are directed to the covering of roofs and flats, laying gutters, covering hips, ridges, and valleys, fixing water trunks, making cisterns and reservoirs, and laying on the requisite pipes and cocks to them, fixing water-closet apparatus, setting up pumps, and applying indeed all the hydraulic machinery required in economic building. The plumber's tools are knives, chisels, and gouges for cutting and trimming, rasps or files and planes for fitting and jointing, a dressing and flatting tool for the purposes its name expresses, iron hammers and wooden mallets for driving and fixing, ladles in which to melt solder, grozing irons to assist in soldering, a hand-grate or stove which may be conveniently moved from place to place for melting solder and heating the grozing irons, a stock and bits for boring holes, and a rule of two feet in length divided into three parts, two of boxwood, the third of steel, for passing into places he may have to examine; also compasses, lines, and chalk for setting out and marking, and centre-bits of all sizes for making perforations, together with weighing apparatus, as the quantities of most of the materials used by the plumber must be either proved or determined by weight. The waste of lead in working is very trifling, as cuttings all go to the melting pot again with little or no loss but that of refounding or casting; and even old lead is taken by the lead merchant in exchange for new at a very trifling allowance for tare and the cost of reworking. A plumber is always attended by a labourer, who does the more laborious work of carrying the materials from place to place, helps to move them when necessary, melts the solder and heats the grozing irons, attends to hold the one or the other, as neither may be set down or put out of hand when in use, and assists in some of the minor and coarser in the temperature of the atmosphere. It may be taken, indeed, as a general rule, that solder should be dispensed with as much as possible. Like glue to the joiner, it is indispensable in many cases; but like glue also, it is in common practice made to cover many defects, and much bad work, that ought not to exist. The soft solder used by plumbers on account of its melting easily is a composition of tin and lead in equal parts, fused together, and run into moulds in shape not unlike the bars of a gridiron. In the operation of soldering, the surfaces of the metal intended to be joined are scraped and rendered very clean; they are then brought close together, and sprinkled with resin or borax at the joints to prevent oxidation while soldering. The heated solder is then brought in a ladle and poured on the joint, and smoothed and finished by a hot grozing iron and rubbed down with a cloth.

Sheet lead, whether cast or milled, is supplied of various weight or thickness, and is always described as of such weight (4 to 12 pounds) to the superficial foot. There are very few purposes, indeed, in building, in which lead of less than 6 ℔ to the foot should be used, and very few in which the weight needs to exceed 10. For roofs, flats, and gutters, under ordinary circumstances, 7 or 8 ℔ lead is a very fair and sufficient average; for hips and ridges, lead of 6 ℔ to the foot is thick enough; and for flashings 5 ℔ lead need not be objected to. Cast lead has been preferred for the former purposes, because its surface is harder, but milled lead is of more even thickness throughout, bends without cracking, which is not always the case with cast lead, and makes neater work. Sheets of cast lead run from 16 to 18 feet long and 6 feet wide; milled sheets are made of about the same width, and 6 or 8 feet longer than cast sheets. Neither the one nor the other may be safely used on flats, or in gutters exposed to the wide range of temperature of our climate, in pieces of more than half the length and half the breadth of a sheet; that is to say, from 8 to 12 feet long, and 3 feet wide, are the limits within which sheet lead will expand and contract without puckering and cracking; and to allow it to move freely it is laid with rolls and drips in such a manner that any extent of surface may be covered with the effect of continuity, though the pieces of lead forming the covering be of such small sizes as above stated. But all *fixing*, whether by soldering or otherwise, is to be carefully avoided. A roll is a piece of wood made about 2 inches thick and $2\frac{1}{2}$ inches wide, rounded on one edge, and fixed with that edge uppermost, so as to come 4 inches within half the width of a sheet, that the edges may be turned up and folded round and over it, being lapped by, or lapping the edge of the adjoining sheet (Plate XXVI. fig. 7). Lead sufficiently stout, dressed neatly and closely down to the boards under it, and over the rolls at its edges, will require no fastening of any kind, unless it be so light as to be movable by the wind. Rolls are used mostly in roofs and flats; drips principally in gutters, though they may be required in long flats. The drip is formed in the first instance by the carpenter in laying the gutter boards, according to an arrangement with the plumber. It is a difference made in the height of the gutter of from $1\frac{1}{2}$ inches to 3 inches, where one sheet terminates in length, and meets another in continuation. The end of the lower is turned up against the drip, and that of the upper is dressed down over it, so as effectually to prevent the water from driving up under it. Where the fall is not great, a piece should be cut out across the higher gutter board, so that the top of the under-lead may lie level with the board. Gutters should have a fall of at least an eighth of an inch to the foot, and in flats it should be rather more, for such a covering is only so called in contradistinction to the pitch of a roof; ends and sides which are against a wall should

Sheet lead. Cast and milled. Rolls. Gutters.

turn up against it from 5 to 7 inches, according to circumstances; and the turning up under the slates, tiles, or other roof covering, to a gutter, should be to the level of that against the wall at the least. The turning up against the wall should be covered by a flashing. This is a piece of lead let into one of the joints of the wall above the edge of the gutter lead, and dressed neatly down over it, to prevent water from getting in behind it (Plate XXVI. fig. 6). Parallel or box-gutters are necessary next parapets where a curb roof is formed, and are useful in valleys of small roofs where the depth for it can be obtained. Fig. 117 is a section of such a gutter next to a parapet wall, in which A is the wall plate; B the tie-beam of the roof; C a bearer for carrying one end of the gutter bearer D, the other end being tenoned into the pole plate K; E the gutter boards carried by its bearers; G the lead gutter, laid in somewhat of an oval shape by the small angle fillets, which are useful in preventing the lead being returned at a right angle, where it is sometimes cracked in laying; H the flashing; I the eaves' board for raising the last row of slates, over which the lead is fixed; L the common rafter; M the slating; N the principal rafter forming part of the truss of the roof; O the saddle-back coping of the wall, throated on both sides. Where thick walls could be obtained, it was usual to form this sort of gutter below the timbers of the roof, whereby they were kept dry, and damage from the overflowing of the gutter prevented. The same result is occasionally achieved by a cornice projecting more than usual, the gutter being formed on it in place of a real blocking course. If the gutters and flats are to be often walked upon, they should be protected by deal lattice work raised on fillets but not fixed. Snow falling down the slopes is prevented by this from stopping the gutters, and it also lessens the action of the sun upon the lead-work. Lead on ridges and hips and the top and sides of dormers, not being in sufficient masses to be secured by its own weight, must be fastened by nails bossed over.

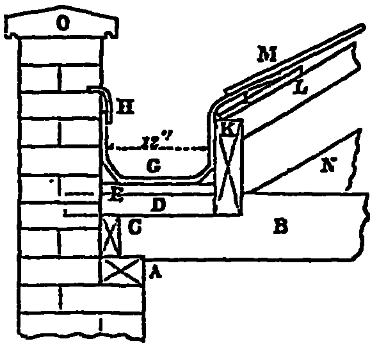


Fig. 117.—Gutter and Roof-Timbers.

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pes. In making cisterns and reservoirs, unless they be cast (and these are now disused), the sheets of lead must of necessity be joined by soldering; but the water they are intended to contain protects the lead from the frequent and sudden changes to which in other and more exposed situations it is exposed. The lead-work forms a lining to a wood case, which has grooved and tongued sides and a bottom. But cisterns are now commonly made of zinc, or of galvanized iron, or of slate; the last two do not require a casing, but may perhaps be enclosed in a closet. Service or water pipes to and from the cisterns, as also waste or overflow pipes, are also made of lead, and described by their bore, as $\frac{1}{2}$ in., $\frac{3}{4}$ in., inch, and so on. They are generally supported and attached to the wall by means of iron boldfasts. Iron water pipes are fixed where lead will probably be stolen. The opinion that some waters are injured by coming in contact with the lead of cisterns and pipes, has led to the formation of pipes of tin encased in lead. The water companies are now requiring a water regulator to be put to each closet, or a water waste preventor where the constant supply is obtained, but these are a very troublesome addition to the plumber's work, on account of the difficulty of keeping them in working order. The constant supply system requires taps of a different construction from those used in other cases; these are called "screw down valves," from their action, and resist the pressure of the water. As repairs must occasionally be needed to the main pipes, it is recommended that, to prevent inconvenience, one or more cisterns be always provided in the house for containing two days' supply of water.

Rain-water trunks and pipes are made of a certain number of pounds weight to the yard in length, according to the bore or calibre that is required. The pipes are fitted with large case heads above, to receive the water from the gutter spouts, and with shoes to deliver the water below; they are fixed or attached to the walls of buildings of stone usually with flanges of lead, which are secured by means of spike nails,—iron and other metals having superseded lead where brick is used or economy requires the substitution.

The varieties of water-closet apparatus, of which Underhay's patent is one of the best, are too numerous to be here described. Pumps of all kinds and powers are amongst the other matters coming within the plumber's province, together with cocks, bosses, ferules, washers. valves, balls, grates, traps, funnels, service boxes, and a numerous collection of other articles.

A metal occasionally used for roofs in lieu of lead is known by the name of Wetterstedt's patent marine metal. It is composed of lead and antimony. Its advantages are its malleability, great tenacity, elasticity, and durability, and its resistance to acids, oxidation, and the action of the sun and atmosphere. It is manufactured in sheets of certain sizes, from 3 lb to 8 ounces per foot, according to the purposes for which it is required, the latter weight being useful for lining damp walls. It should be secured with wrought copper nails. A patent metallic canvas is also manufactured of various substances and strength, serving for waterproof and secure covering. Patent marine metal.

Sheet copper was formerly used on account of its lightness to cover roofs and flats. The thickness generally varied from 12 to 18 ounces per square foot. It was laid like lead, but the plates being of small size were soldered together. It will be well to notice that water collected from copper channels must not be used for culinary purposes, as a film of verdigris is formed, which is poisonous. Copper is much used for roofing in foreign countries. Copper roofing.

Lead and copper, where economy is required, are superseded by zinc, which is not only much cheaper, but when good is nearly as durable, and is not so liable to be corrugated by the action of the sun. Zinc is subject to oxidation; but the oxide, instead of scaling off as that of iron does, forms a permanent coating on the metal. Its expansion and contraction are greater than those of any other metal. Zinc sheets as manufactured vary in quality, some being very brittle. That supplied by the Vielle Montagne Zinc Mining Company possesses a high reputation for purity and excellence. Zinc must be laid like lead, without fixing either by nails or solder. No. 13 gauge, weighing 19 oz. 10 drs., is the least for roofs, flats, and gutters on boarding. No. 14, a medium thickness, weighing 21 oz. 13 drs., is used for roofs and flats; and No. 15 or 16, weighing 24 oz. and 26 oz. 3 drs. per foot superficial, for best work and roofs without boards. Zinc pipes are extensively used as chimney pots; stamped and moulded ornamental zinc for dormers, Mansard roofs, vanes, guttering, and rain-water pipes, cisterns, &c.; and perforated zinc for blinds and for ventilation. Zinc roofs

Tin cannot class with the building materials in England, although it is extensively used for covering roofs in America and in Russia. Tin roofing.

The best publications on this trade are the makers' price books and lists of articles made and sold by them. See also the article METALLURGY.

Plaster-work.

No art in the economy of building contributes more to produce internal neatness and elegance, and no one is less absolutely important, so far as the use and stability of a structure are concerned, than that of the plasterer. The very general application of plaster is of comparatively late date; for wainscoted walls, and boarded or boarded and canvased ceilings, or naked joists alone, are frequently found in houses of rather over a century old, both in England and on the Continent; and a return to this state of completion in the present day is the result of the attempts of the mediæval school of architects, and their cry of "no shams," which has not been quite successful among themselves, for plaster and cement are used by many. The walls of houses were formerly plastered above the wainscoting and coloured, while the ornamented plaster ceilings of the time of Henry VIII., Elizabeth, and James I., are still the admiration of lovers of the art. Still earlier specimens of the plasterer's skill are extant in the pargetted and ornamented fronts of half-timber houses.

For the more common operations of plastering comparatively few tools and few materials are required. The plasterer is attended by a labourer, who supplies his boards with mortar, and by a boy on the scaffold with him to feed his hawk, which is a piece of wood about 10 inches square with a handle under it, for carrying up small portions of plastering mortar to the wall or ceiling, to be there delivered and spread by the trowel, a thin plate of hardened iron or steel with a wooden handle, similar to that used by the bricklayer. The plasterer is obliged to keep this implement particularly clean and dry when he is not actually using it, lest it rust in the slightest degree, as it is clear that the brown oxide of iron would sadly discolour his finer work on touching it againwith the trowel. He is necessarily furnished with a lathing hammer, a hand float, a quirk float, and a derby or darby, which is a long two-handled float for forming the floated coat of lime and hair; brushes for fine or rough work; three or four jointing trowels for mitres, &c.; jointing rules; moulds for cornices, which are of wood, but for work of any importance the frame is made of wood and the outline cut out of a copper (or more usually zinc) plate,—these are inserted in the wooden stock, and narrow pieces of wood are fixed to the moulds transversely to guide and steady them along the screeds; a straight edge, wherewith to bring the plastering on a wall or ceiling to a perfectly even surface by traversing it in every direction; a screen, having metal wires to act as a sieve for separating the coarser materials which enter into the composition of plastering mortar,—these are thrown against its outer face, to separate the particles which are too large for the purpose from the finer,—the sand and lime, too, are mixed much more efficiently and completely by screening them together than in any other manner; a spade and hod like those of the bricklayer's labourer; a rake to separate the hair used in the mortar and distribute it throughout the mass; and a server for the hawk boy to beat up the mortar, and to deliver it in small pats on the hawk.

terials. The plasterer, as the term imports, works in plastic, adhesive compositions, which are laid on walls, both internally and externally, to stop crevices, reduce inequalities, and produce an even, delicate surface, capable of receiving any decoration that may be applied to it, either in colour or otherwise. These compositions are as various as the modes of applying them, the rudest being a compost of loam, a marly clay, and lime; this is used only for the commonest purposes, and being laid on in one coat, is washed over with a thin mixture of lime and water, a process termed lime-whiting. There are many grades from this to the highest work of the plasterer,—the making imitations of marbles and other costly stones, from the purest calcined gypsum mixed with a solution of gum and isinglass and colouring matter to produce the required imitation. His materials are laths, lath nails, lime, sand, hair, and plaster, a variety of stuccoes and cements, together with various ingredients to form colouring washes, &c. Scaffolding is not Scaff generally required for new work, but with old work it is sometimes necessary. Under ordinary circumstances, the plasterer is enabled to wash, stop, and whiten the ceilings and walls of rooms from trestles, with boards laid across them. In lofty saloons and halls, churches, &c., scaffolding is indispensable. It is necessary, too, to a front that is to be plastered in any way; but this may be afterwards washed, repaired, and coloured from a ladder, without the intervention of a scaffold, except perhaps the suspended scaffold now so much used.

Laths are narrow strips of some straight-grained wood, Lath generally of fir, though oak laths are sometimes used, in lengths of 3 and 4 feet, or to suit the distances at which the joists of a floor or the quarterings of a partition are set, and in thickness from $\frac{1}{8}$th to $\frac{3}{8}$ths of an inch; those of the greater thickness are called lath and a half. Lath nails are either wrought or cut; cut nails are in common use in England with fir laths. Coarse stuff is composed of ox Coar or horse hair from the hide, in addition to lime and sand stuff. mortar; this is intended to act as a sort of mesh to net or tie it together, and form a coarse but plastic felt. The hair should be long, and free from all grease and filth. Road drift is unfit to be used in place of clean sharp sand in mortar, unless it be completely cleansed from all animal and vegetable matter, and of mud and clay. Fine stuff is made of fine white lime, exceedingly well Fine slaked with water, or rather macerated in water to make the slaking complete; for some purposes a small quantity of hair is mixed up with this material. The mere paste, when allowed to evaporate until it is of a sufficient consistence for working, is called putty. Gauge stuff is composed of Gaug about three-fourths of putty and one-fourth of calcined stuff. gypsum or plaster of Paris; this may be mixed only in small quantities at a time, as the plaster or gauge renders it liable to set very rapidly. Bastard stucco is made of Stucc two-thirds fine stuff, without hair, and one-third of very fine and perfectly clean sand. Common stucco is composed of about three-fourths of clean sharp sand and one-fourth of the best lime, well incorporated. This must be protected from the air from the time it is made up until it is required to be laid on the walls. Parker's (or Parker's Roman) cement, when of good quality, with fine clean sharp sand, Ceme in the proportion of about three of sand to one of cement, and well executed, forms a very good external coating for walls. It is vulgarly called "comps," a contraction of "composition." Portland cement, so called because the mortar formed by it when mixed with sand is supposed to present the appearance of stone from the Portland quarries, is in much esteem for an outside stucco, as the colour to which it dries is sufficiently agreeable to the eye without any colouring wash, whereas Parker's cement is too often of a dark dirty tint, requiring painting or colouring to render it tolerable. Portland cement is also much valued as being proof against water when used as a mortar in setting brick-work, and in the composition of concrete for foundations. The patent selenitic cement already described (page 459), is stated to be an excellent substitute for Portland cement; it takes double the usual quantity of sand, and is stronger even then than ordinary mortar. Plastering is finished in much less time than by the common mode.

A class of cements capable of taking a brilliant polish resembling marble, and consequently very suitable for internal decoration, deserves to be mentioned. The chief

of these are Keene's marble cement and Parian cement. They become excessively hard in a short time, and are capable of being painted in a few days. The principal component is said to be obtained by the precipitation of alum by an alkali, which gives a white powder of great brilliancy. Tints can be made up with these cements for coloured decorative work. Cements made by the mixture of oil with various substances were formerly much used both here and abroad. The best known in England was called Hamelin's mastic, that in France the mastic de Dhil. These cements being very expensive, and requiring to be constantly painted, have now gone nearly out of use. For outside plastering they form a very fine clean surface, as may be seen in the quadrant in Regent Street and other buildings of that date, but in many instances it has been taken off and Portland cement substituted.

Blue lias lime.

Blue lias lime was formerly greatly esteemed as a cement for outside work, but the carelessness of the burners has tended much to limit its use, there being a large proportion of underburnt stone left in it. The workmen also would not take the requisite pains for slaking this lime, and manufacturers therefore ground it, by which operation the core becomes mixed up with the properly burnt material, and the efficiency of the lime is destroyed. The lumps should be broken as small as nutmegs, then immersed in water on a sieve until air-bubbles freely rise to the surface; the lime so wetted is to be left in a heap covered by damp sand for twenty-four hours, after which time it should be screened and mixed with the proper quantity of sand and the least possible quantity of water. To one of lime may be put not more than from two to two and a half of sand. When slaked it does not increase in bulk.

Coats of plastering.

The various coatings of plastering are distinguished thus. On laths, plastering in one coat simply is said to be laid, and in two coats, laid and set. In three-coat plastering on laths, however, the first is called the pricking up, the second is said to be floated, and the third set. On brick or stone walls, plastering in one plain coat is termed rendering; with two coats, a wall is said to be rendered and set; and in three, rendered, floated, and set.

Lathing ceilings.

Before beginning to lath a ceiling, the plasterer proves the under face of the joists, to which he has to work, by applying a long straight edge, and makes up for any slight inequalities in them, when the work is not to be of a very superior description, by nailing on laths or slips to bring them as nearly even as he can. When the inequalities are great, or if the work is to be of fine quality, he recurs to the carpenter, who takes off inordinate projections with his adze, and nails on properly dressed slips where the joists do not come down low enough, and thus brings the whole to a perfect level. This operation is called firring, or furring. If it be a framed floor with ceiling joists the plaster has to work to, it is tolerably sure to be straight; but the carpenter must have firred down on the beams or binders to the level of the ceiling joists, unless the ceiling joists have been nailed to the beams or binders, when nothing of this kind is necessary. If a ceiling is to be divided into compartments or panels, the projecting or depending portions must be bracketed or cradled down to receive the laths. It is an important point to be attended to in plastering on laths, and in ceilings particularly, that the laths should be attached to as small a surface of timber as possible, because the plastering is not supported or upborne by its adhesion or attachment to the wood, but by the keying of the mortar itself, which passes through between the laths, and bends round over them. If then the laths are in constantly recurring contact with thick joists and beams, the keying is as constantly intercepted, and the plastering in all such places must depend entirely on the portions between them which are properly keyed. Under a single floor, therefore, in which the joists are necessarily thick, a narrow fillet should be nailed along the middle under the whole length of them all, to receive the laths and keep them at a sufficient distance from the timber to allow the plastering to key under it; thus too the surface may be made more perfectly even, as it is in single floors that inequalities mostly occur. This being all arranged, the plasterer commences lathing. The laths should be of the stronger sort. Thin weak laths, if used in a ceiling, are sure to produce inequalities, by sagging with or yielding to the weight attached to them; one or two weak ones in a ceiling of otherwise strong laths may be the ruin of the best piece of work. They should be previously sorted, the weak, crooked, and knotty, if there be such, being reserved for inferior works, and the best and straightest selected for the work of most importance, so that the workman shall find none to his hand that is not fit to be brought in. Taking a lath that will reach across three or four openings, he strikes a nail into it on one of the intermediate joists, at about three-eighths of an inch from the one before it, and then secures the ends of that and the one that it meets of the last row with one nail, leaving the other end of the lath he has just set to be secured in the same manner with that which shall meet it of the next bay in continuation. It is of importance also that in ceiling-work he pay attention to the bonding of his work. In lathing on quartering partitions and battened walls, the bonding is not a matter of much importance; nor is the thickness of the timbers behind the latter of so much consequence as in a ceiling, because the toothing which the thickness of the lath itself affords to the plastering is enough to support it vertically; but, nevertheless, the more complete the keying, even in works of this kind, the better, as the toothing above will not protect it from any exciting cause to fall forwards, or away from the laths. The thinner or weaker sort of lath is generally considered sufficiently strong for partitions.

When the lathing is completed, the work is either laid or pricked up, according as it is to be finished with one, two, or three coats. *Laying* is a tolerably thick coat of coarse stuff or lime and hair brought to a tolerably even surface with the trowel only; for this the mortar must be well tempered, and of moderate consistence,—thin or moist enough to pass readily through between the laths, and bend with its own weight over them, and at the same time stiff enough to leave no danger that it will fall apart,—a contingency, however, that in practice frequently occurs in consequence of badly composed or badly tempered mortar, unduly close lathing, or sufficient force not having been used with properly consistent mortar to force it through and form keys. If the work is to be of two coats, that is, laid and set, when the laying is sufficiently dry, it is roughly swept with a birch broom to roughen its surface, and then the set, a thin coat of fine stuff, is put on. This is done with the common trowel alone, or only assisted by a wetted hog's bristle brush, which the workman uses with his left hand to strike over the surface of the set, while he presses and smoothes it with the trowel in his right. If the laid work should have become very dry, it must be slightly moistened before the set is put on, or the latter, in shrinking, will crack and fall away. This is generally done by sprinkling or throwing the water over the surface from the brush. For floated or three-coat work, the first, or pricking up, is roughly laid on the laths, the principal object being to make the keying complete, and form a layer of mortar on the laths to which the next coat may attach itself. It must, of course, be kept of tolerably equal thickness throughout, and should stand about one-quarter or three-eighths of an inch on the surface of the laths. When it is finished, and while the mortar is still quite moist, the plasterer scratches or scores it all over

ith the end of a lath in parallel lines from 3 to 4 inches art. The scorings should be made as deep as possible thout laying bare the laths; and the rougher their ges are the better, as the object is to produce a surface which the next coat will readily attach itself. When e pricked up coat is so dry as not to yield to pressure in e slightest degree, preparations may be made for the ating. Ledges or margins of lime and hair, about 6 or inches in width, and extending across the whole breadth a ceiling or height of a wall or partition, must be made the angles or at the borders, and at distances of about 4 t apart throughout the whole extent; these must be de perfectly straight with one another, and be proved every way by the application of straight edges; techni-ly these ledges are termed *screeds*. The screeds are gauges the rest of the work; for when they are ready, and the rtar in them is a little set, the interspaces are filled up sh with them; and a derby float or long straight edge ng made to traverse the screeds, all the stuff that projects yond the line is struck off, and thus the whole is brought a straight and perfectly even surface. To perfect the rk, the screeds on ceilings should be levelled, and on lls and partitions plumbed. When the floating is suffi-ntly set and nearly dry, it is brushed with a birch broom before described, and the third coat or set is put on. is for a fine ceiling that is to be whitened or coloured st be of putty; but if it is to be papered, which is very usual, ordinary fine stuff, with a little hair in it, will be ter. Walls and partitions that are to be papered are of this latter, or of rough stucco, but for paint the set st be bastard stucco trowelled. This coat must be ked of exactly the same thickness throughout, to pre-ve to the external surface the advantage that has been ained by floating. For all but the last-mentioned, the on floated work, the trowel and brush are considered icient to produce fine and even work; but trowelled cco must moreover be hand floated. In this operation stucco is set with the trowel in the usual manner, and ught to an even surface with that tool to the extent of or three yards. The workman then takes the hand-t in his right hand, and rubs it smartly over the surface, sing gently to condense the material as much as pos-e. As he works the float he sprinkles the surface with er from the brush in his left hand, and eventually duces a texture as fine and smooth almost as that of ished marble.

But lathing and plastering on laths as practised in gland is at best a very flimsy affair, and greatly uires improvement. Stronger laths than the laths nmonly employed, put on further apart, and with headed ught nails, and the plastering laid on upon both s in upright work, or both above and below the ceilings he same time, two men working against one another, l produce work in some degree worthy of the name. practice of the French in this respect is well worthy consideration, and to a great extent the imitation, of ...

work behind it, and be incorporated with it as much as possible. As its name imports, its surface may, indeed should, be rough; but it is not scratched or lined as the similar coat on lath is. For this, too, the wall must be previously wetted, that the mortar may the better attach itself to it. For the floating, screeds must be formed as before described, and the consecutive process is exactly the same as on lath, both for the floated and for the set coat. In almost every case in which plastering is to be floated, the workman finds a guide for the feet of his wall screeds in the narrow grounds which the joiner has previously fixed for his skirtings; from these he plumbs upwards, and makes his work perfectly flush with them.

Mouldings and cornices.

Mouldings and cornices (as large combinations of mouldings and flat surfaces immediately under the ceilings of rooms are called) are formed with running moulds, and are generally executed before the setting coat is put on the walls and ceiling. If the cornice do not project more than about an inch and a half, or 2 inches, from the ordinary work, a backing of lime and hair will be sufficient; and if any one part only happen to be more than ordinarily protuberant, a row of nails from 6 to 12 inches apart stuck into the wall or ceiling in the line of that part will give it sufficient support. But if the general mass of the cornice be more than that amounts to, and extend more than 6 or 8 inches along the ceiling, it must be bracketed out, and the bracketing lathed and pricked up, as for ordinary work. This pricking up, or other preparation, must of course be perfectly set before the cornice is run; and there should be one-fourth of an inch at least of clear space between the preparation and the mould in the nearest part. A wooden screed or parallel straight edge is tacked on with brads to the wall, and another on the ceiling, if the cornice be large and heavy, as guides or gauges for the mould, whose rests are chased to fit them; and then one man laying on gauge stuff in an almost fluid state with an angular trowel, another works the mould backwards and forwards over it, which strikes off what is superfluous, and gives the converse of its form to the rest. The mould is never taken down from the work at right angles to the line of it, but is drawn off at the end, so that none of the parts of the moulding or cornice is injured or torn by it, which must otherwise frequently be the case, from the peculiar forms at times given to the details. If a cornice be too large and heavy to be executed at once, it may be done in the same manner at two or more times, in so many parts; and if any part or parts of a moulding or cornice is to be enriched, the space for it is left vacant by the mould, and the enrichment is afterwards supplied. As a cornice cannot be completed up to the angles by the mould, it is worked by hand in those situations to a joint. The joinings are termed mitres, and in forming them the plasterer uses the jointing tools we have already described.

Enrichments.

Models for enrichments are made by the modeller, according to the design or drawing submitted to him, and from them the plasterer makes wax or gelatine moulds, or, as in ordinary practice, the modeller supplies the moulds in which the ornament is cast in plaster of Paris. If the ornament be in recurring lengths or parts, as is usually the case, only one length or part is modelled, and casts of as many as are required are taken from the mould; some single ornaments, again, which are very large, require to be moulded and cast in parts, which are put together by means of cement. When the cast ornaments are sufficiently dry the pieces are scraped and trimmed, and the joints made clean and even; and they are set in the cornice with plaster of Paris, with white lead, or with a composition called iron cement, as the case may require. If the castings have something in the cornice to rest upon, the first will do; but if there is nothing to retain or attach them but the

cement, one of the last two must be used. Flowers and other ornaments on ceilings which are too large and heavy to be trusted to adhesive matter alone, must be screwed to wooden cradling behind and above them.

Plastering with stucco. In plastering a wall with common stucco (and its use is mostly for outside work), the first thing to be done is to remove the dust from it by brushing, and then to wet very completely with water. If the wall to be stuccoed be an old one, or one of which the joints have been drawn, the mortar of the joints must be chipped or even raked out, and the bricks picked, to expose a new and porous surface to the plastering before brushing and wetting. The wall is then covered with stucco in a fluid state, applied with a broad and strong hog's bristle brush, like common white-washing. When this is nearly dry the stucco must be laid on as in common rendering, unless the work is to be floated, when the process is nearly similar to that in floated plastering. Screeds must be formed at the highest and lowest extremities of the wall, or of that part of the wall which is in the same vertical line, and is not intercepted by string courses, and be returned at the angles, putting the whole surface into a sort of frame. These must be made perfectly straight and plumb, so as to be quite out of winding by the careful application of the plumb-rule and straight edge. Inner vertical screeds must then follow at three or four feet apart across the whole surface, and be made to range exactly with the outer ones, and then the interstices must be filled in as before. As the work is made good it must be well rubbed with the hand float, as in the execution of trowelled stucco internally, to compress the material, and produce a hard, even, and glossy surface. Preparations for cornices and other projections from the straight surface of the work must have been previously made in or on the brick or stone-work by the protrusion of bricks, tiles, or whatever may be best suited to form a core; and the mouldings and cornices are run with moulds, in the manner described for the same things internally, only that in work of this kind no plastic material but the stucco itself is used,—that is, there is no preparation of any softer material than the stucco itself put under it. In running cornices in this material, workmen are very apt to mix a little plaster of Paris with the stucco to make it set under the mould, and thus give sharpness and fulness to the mouldings; but this should not be permitted; for the plaster is not qualified to stand the weather as the stucco is, and, if mixed with it, will produce premature decay. When the stucco is perfectly dry, it may be painted in oil colours, or be coloured in distemper; and in either case it is generally (though not invariably) ruled over the surface with a lead point, to give it the appearance of gauged stone-work.

Outside cement-work. Rendering in the Roman and Portland cements is executed almost exactly in the same manner as stucco rendering is, only that it is laid on the saturated wall directly, without the preliminary operation of roughing in, or washing the surface with a solution of the material. The same process, too, is followed in floating this cement, and with the same exceptions; and as, in addition to its superior hardness and capacity for duration, it is a quick-setting cement, it is far preferable to any of the common stuccoes for running cornices, mouldings, &c. These cements may, like stucco, be painted in oil, or coloured; but instead of a size colour, which is used for almost every other purpose in plastering, the colour for this composition is mixed with diluted sulphuric acid. This too may be lined and tinted to imitate stone and stone-work of any description.

Decay of stuccoes and cements. It may not be amiss here to refer to some of the causes of the premature decay which takes place in stuccoes and cements when used externally as a coating to walls. The primary cause is the presence of muddy earth and decayed animal and vegetable matter in the sand used with the lime and cement. To this may be added frequent impurities in the limes and cements themselves, particularly of argillaceous matter in the former, and sometimes the too great proportions of lime or cement to sand. These things might, however, remain quiescent for a long time, if the work were well protected from access of moisture, which is the grand exciting cause. The paint, or distemper wash, on the surface, is generally sufficient to prevent the rain which may beat against a vertical face from penetrating, especially if the work have been well hand-floated and trowelled, to make it close and compact; but the evil arises from exposure above, and from the numberless horizontal unfloated surfaces which are constantly presented. These receive and collect the water, and convey in streams over the vertical surfaces what is not immediately absorbed; and the work thus becoming saturated, frost seizes and bursts it, or warmth calls the vegetative powers of the impurities in it into action, and the whole is covered with a green sward. Let the sand of which a plaster composition is to be formed, whether with lime or cement, be washed until it no longer discolours clean water, and be well compounded with cementitious matter free from impurities with which it is so frequently charged; let the work be well hand-floated and trowelled, particularly on the backs or upper horizontal surfaces of projections, and protected above by projecting eaves or otherwise; and the work, with common care and attention to paint or distemper at intervals, will last as long as anything of the kind can be expected, or is found, to last anywhere.

Rough-cast. A cheap and useful covering for external walls, which are protected by projecting eaves, in plain buildings, is rough cast. This is executed in the following manner:—The surface is first roughed, or indented, and then well brushed with a stiff brush to remove all dust or loose earth. It is then covered with the rough cast, which consists of a small quantity of mortar diluted with water, to which a trowel of pure lime is added to make it about the thickness of cream. After the workman has done all within his reach the scaffolding is lowered, and he proceeds with the remainder. Another process is somewhat dearer. After having been roughed or indented, the wall is sprinkled with water, and then rendered with lime and hair; and when that is set, another coat of the same material is superadded, laid as evenly as it can be without floating, and as soon as a piece of two or three yards in extent is executed, the workman lays on it an almost fluid mixture of clean fine gravel and strong lime, which have been well mixed together. This is immediately washed with any ochreous colour that may be desired, and the whole dries into one compact mass. A third process, called stuccoing, is performed by the workman laying on a few trowels of stucco, which he spreads as much as possible; a second workman provided with a brush and a small wood float follows him, and after sprinkling the mortar with water he rubs over that part he has wetted with the float, and at the same time it may be whitened with lime alone. When the lime is very good this makes very good work.

Repairs. In renovating and repairing plastering the whole surface is first well washed to remove the dirt which may have attached itself, and as much of the earthy matter of the previous coat of whitening or colouring as will come away; any injuries the work may have received, such as cracks and fractures, are then repaired; and when the new stuff is quite dry, the joinings are scraped to produce an even surface, and the whole is again whitened or coloured once or twice or oftener as may be required, to make it bear out well. Stuccoed walls which have been painted must

be well rubbed with pumice stone, to take off the old paint as much as possible before the new work is proceeded with.

d ring. For a decoration to rooms having plastered walls, instead of papering or flat painting, or for a suitable ornamentation for the interior of churches built at small outlay, the old system of pargetting has been revived. The usual stucco or other plaster finish is, while still wet, stamped over with a pattern made of brass, or for rougher work of wood, to any geometrical or other form in accordance with the style of architecture; this indents the surface. It may be left all of one colour, or the open portions of the device may be filled in with another coloured plaster.

ito. Another revived method, especially for outside work, now much in use is called sgraffito. It was in vogue with the Italian artists about two centuries since, who executed some very elaborate specimens of ornamentation with it. The process is briefly as follows:—First, mix with the mortar some colouring substance of the tint desired for the pattern of the design; then apply a thin coat of it to the wall. When this coat is nearly dry, apply on it another coat similarly prepared but of the colour intended for the grounding, and then, a mould having been prepared in zinc of the exact outline of the pattern, it is to be applied to the surface, its outer edge marked round, and with a sharp tool as much of the upper coat of plaster is cut away as comes within the pattern, down to the face of the lower coat. By a careful arrangement of pattern, a considerable variety of colouring may be employed; and even three coloured coats can be put on, cutting through sometimes one, sometimes two, as may be desired to represent the design. As the colour is in the material itself, there is no fear of its scaling and so presenting a bad appearance; and it is a comparatively cheap process for the decoration of a new surface which cannot be painted for some time. The process has been adopted in England with coloured cements for outside work.

Under the plasterer's trade it may be desirable to mention some of the varieties of artificial marbles, scagliola, and other similar work for the decoration of buildings.

liola. Scagliola is a species of plaster or stucco invented about 1600–50 in Italy. The work is lathed and plastered as usual, and then the artist commences, preparing his material, which is composed of the purest gypsum broken into small pieces and calcined, passed through a very fine sieve and mixed up with glue, isinglass, &c. In this solution the colours are diffused that are required to be imitated in the marble; or the colours are prepared separately, and afterwards mingled and combined nearly in the same manner that a painter mixes the primitive colours on his palette to compose his different tints. When the gypsum is prepared and mingled, it is laid on the plaster, and then floated with proper moulds of wood, the artists during the floating using the colours necessary for the imitation, by which means they become mingled and incorporated with the surface. The process of polishing follows, first by means of pumice stone, then with tripoli and charcoal and fine and soft linen; after this the surface is rubbed with a piece of felt dipped in a mixture of oil and tripoli, and last of all with pure oil. The imitation may be so good that except by fracture or by sound it cannot be discovered to be a counterfeit.

er tation bles. Marezzo marble is made of cement mixed with fibre for strength and to resist a blow. Slabs are bedded on plaster of Paris, and with cramps and dowels like marble. Every variety of marble can be imitated in it, and it receives a high and permanent polish. The Marbre Universel Company have put forward a new manufacture of a similar description.

Modelling, Carved Work, and Gilding.

The modeller copies the drawings of the designs which may have been prepared for the enrichments, in whatever material they are to be cast, whether in plaster, in metals, or in composition of any kind, for the plasterer, smith, or decorator. The model is made of soft wood, by the usual chisels and gouges, or in a finely-tempered and plastic clay called modelling clay, or in wax. The modeller works the clay with his fingers, assisted by a few ivory, bone, or steel tools for finishing off neatly and sharply, and for working in parts which he cannot reach with his fingers. The best workman is one who can do most towards producing the required forms with his fingers, unassisted by artificial tools, as a greater degree of ease and freedom almost always results from the use of the hands alone. The model being completed, it is moulded, that is, a mould or moulds are made from it of a preparation of resin or of gelatine, sometimes of plaster of Paris; the moulds, if they have to be formed in portions, are fitted exactly to each other at the edges, and in these moulds casts in plaster of Paris or other material are made to any extent that may be required. For smith's work the wood model is sent to the founder for casting in metal. For carved work, such as caps of columns, shields, medallions, consoles, &c., the model may be sent to the mason or stone carver for the completion of the block, which may have been left in a boasted state by the mason when setting it. Mode

The modeller having some pretensions to be considered an artist rather than a mere artificer, is for the most part paid according to his merits, rather than for so much time, according to the ordinary mode of determining the value of artificers' works.

The carver is strictly an independent artist, whose business it is to cut ornaments and enrichments in solid and durable material, such as stone and wood, so that, like the modeller, he must be paid according to the taste and power he may exhibit in his works, rather than as a common artificer. The art of carving has, however, been in a great measure superseded by modelling and casting. In works of a free style, or of a mediæval character, the carver is often left free to exercise his own taste and fancy or talents in the execution, with or without a sketch by the architect before him. The decorator, in addition to casts in plaster of Paris, now makes use of composition ornaments, which are formed of a mixture of whiting and glue pressed into moulds; or of papier mâché, which is paper pressed into moulds; or of a composition of a thin coat of plaster of Paris poured into the mould, and then covered with coarse canvas, the result being to all appearance a plaster cast, but it is far lighter in weight,—a figure the size of life being readily moved about by one person. It was an old process revived by the late Mr Owen Jones, and well carried out for him by M. Desachy, in the elaborate ornamented ceiling at St James's Hall, Piccadilly. Carved work. Decora work.

Gilding is applied to castings as well as to carvings; but the former being, almost as a matter of course, less sharp and spirited in their flexures and details, as well as less firm in substance than the latter, castings can less bear to be further subdued by the application of foreign matters to their surfaces than carvings may. Gilding is the application of gold leaf to surfaces, which require, however, to be previously prepared for its reception. The work is first primed with a solution of boiled linseed oil and carbonate of lead, and then covered with a fine glutinous composition called gold size, on which, when it is nearly dry, the gold leaf is laid in narrow slips with a fine brush, and pressed down with a piece of cotton wool held in the fingers. As the slips must be made to overlap each other slightly, to insure the complete covering of the whole surface, the loose Gilding

edges will remain unattached; these are readily struck off with a large sable or camel-hair brush, fitted for the purpose; and the joints, if the work be dexterously executed, will be invisible. This is called oil gilding, and it is by far the best fitted for the enrichment of surfaces in architecture, because it is durable, and is easily cleaned, and does not destroy or derange the forms under it so much as burnished gilding does. The latter requires the work to be covered with various laminæ of gluten, plaster, and bole, which last is mixed with gold size, to secure the adhesion of the leaf.

Glazing.

The business of the glazier, the manufacture of whose material has of late years improved and progressed in a very remarkable degree, may be confined to the mere fitting and setting of glass; even the cutting of the plates up into squares being generally an independent art, requiring a degree of tact and judgment not necessarily possessed by the building artificer.

Tools. The glazier is supplied with a diamond or other cutting tool, laths or straight-edges of various lengths, a square, a glazing-knive, a hacking knife, a hammer, a duster, a sash-tool, a two-foot rule, and a machine called a glazier's horse, which he fixes outside a window sill, and stands on to reach the upper panes for glazing or cleaning purposes, without removing the sash, and so injuring the beads and paint.

Materials. His materials are simply glass, putty, and priming or paint. The glass is supplied by the glass-cutter, of the qualities and sizes required for the particular work to be executed. The putty is made by the glazier himself, or by a labourer, of fine clean powdered chalk or whitening, well mixed and combined with linseed oil, and kneaded to the consistence of dough. No more putty should be made at once than is likely to be worked up in the course of a few days, as, the oil drying out, it becomes hard and partially set, and is therefore less available for its purposes. Priming is a thin solution of white (with a little red) lead, mixed in linseed oil. For ordinary glass, the sashes are sent to the glazier from the joiner, after having been fitted into their places, and only require to be glazed before they are permanently set or hung.

Glazing operations. Supposing that no preliminary process is required, such as stopping (the result of bad joiners' work) and knotting (and knotty stuff should not be admitted in sashes), the sashes require to be primed. The priming is laid on every part of the sash except the outer edges of the styles and of the bottom and top rails, with the sash tool or painting brush, that is, if the sashes are intended to be painted; for if not, the rebates only must be primed. The object of this is to prepare the material of which the sash is composed for the reception of the putty, which would not otherwise attach itself so firmly as it does after this preparation. The priming being sufficiently dry, the workman cuts the panes of glass down into their places, making every one fall readily into the rebates without binding in any part; indeed the glass should fit so nicely as not to touch the wood with its edges anywhere, and yet hardly allow a fine point to pass between it and the sash-bar or rebate, the object being to encase it completely in putty, and yet that the putty should not be in greater quantity than is absolutely necessary. The glass being fitted or cut down, the workman takes the glazing-knife in his right hand, and a lump of putty in the palm of his left, the sash being laid on its face, that is, with the rebates upward, before him; with the knife he lays a complete bedding of putty on the returning narrow stops of the rebates, all round to every pane. This being done, the panes of glass are put on it as they have been fitted, and every one is carefully rubbed down with the fingers, forcing the putty out below and round the edges of the glass, until they are nearly brought into contact with the wood or other material of the sash. The rebates are then filled in with putty behind, the mass forming exactly a right-angled triangle, its base being the extent of the stop of the rebate, and its perpendicular the depth from the glass to the outer edge of the rebate; and the third side or hypothenuse is neatly smoothed off. The sash being then turned on its edge and held upright by the left hand, the protruded putty of the bedding, or back putty as it is called, is struck off with the knife, and the section of it neatly drawn. The sashes are now deposited on their faces to allow the putty to set, and then they may be hung and painted.

To very large squares, and to plate glass, needle points, or small nails called sprigs, are used to retain the material securely in its place while the putty is soft and yielding. These have to be carefully inserted, for if they fix the glass it is apt to fly at any sudden vibration. Large squares and plate glass are usually inserted after the sashes are hung, to prevent risks of breakage. Where the bar and frame can be made to allow of it, large squares are secured in their place by wood beads screwed to the rebate in lieu of putty. In this case the edge of the glass is first covered with a piece of flannel, or thin india-rubber, to fill up crevices, and so prevent admission of dust, and stop any current of air.

Lead-work, as it is termed, is the glazing of frames rather than of sashes with small squares or quarries of glass, which are held together by reticulations of lead; and these are secured to stout metal bars, which are fixed to the window frames. Leaden reticulating bars are grooved on their edges to receive the quarries, and are tied by means of leaden ribands or wires to the saddle bars, which, in their turn, are affixed to the stouter bars before mentioned, if the bay or frame be so large as to require both. This is now extensively carried on in the painted glass window shops, where the glass is cut to patterns, and shows outlines of figures, costumes, &c. "Stained glass" is obtained by mixing colours in the pot while in the furnace, hence the term "pot metal" for it. A kind of coloured glass has only a skin of colour on one side of the white material, and hence is termed "flashed glass." Lead-w

Besides all the varieties of clear glass, the glazier has Va.. now at his command the many qualities of obscured glass, glass. beyond the ground and painted glass of former days; the lace-pattern glass, executed by laying a pattern on the material which has been covered with a varnish, placing it in a box filled with a fine powder, which when shaken adheres to the varnished portions, and then putting it in a kiln where it becomes fixed; the patent rough plate for conservatories, workshops, &c., and its fluted varieties; the rough cast plate for workshops and store-houses; the stained ornamented quarry for church windows, &c. Lastly, there is the engraving on glass by aid of the sand blast,—a new and easily managed method, consisting in a jet of air blown violently through a tube, carrying with it particles of fine sand. The action is very rapid, and it reduces the surface in a few minutes to the condition of ground glass. A piece of lace, however, is sufficient to arrest the action of the sand. Reece's patent embossed and coloured glass is useful for screens and for windows which are not meant to be looked through.

Coming within the scope of the glazier's business is the novel pavement light, consisting of a frame of iron cast with small many-sided apertures, into which are placed a series of dome-shaped or prism-shaped blocks of glass, reflecting the light falling upon them. They distribute the light to a greater extent than a piece of rough plate-glass, and like Chappuis's and other reflectors require to be kept clean. Moore's window ventilator allows of the

admission of air through its louvres, which are worked by a wire or cord as necessary. Hartley's patent perforated glass attempts to gain the same end by small slits formed in the pane.

For publications relating to the glazier's chief material, see the article GLASS. For patterns of lead-work, see Shaw's reprint of W. Gidde, *Booke of Sundry Draughtes*, 8vo, 1615.

SMITH-WORK AND GASFITTING.

The smith is the worker in wrought metals of all kinds required chiefly by the carpenter and joiner, who fixes them in the building. Smithery is the art of uniting several lumps of iron into one lump or more, and forging them to any desired shape. The earlier parts are done at the forge and on the anvil with the hammer, and hence is produced "wrought work," whether for useful or for ornamental purposes. Machinery has been brought extensively to the smith's assistance, for rolling, drilling, planing, &c. The ornamental portion of his work is wrought iron shaped by hand into devices and patterns according to the various styles of architecture, as in gates, railings, standards, hinge bands, locks, handles, knockers, lanterns, candlesticks, and other lighting contrivances, which are also executed in brass-work and in cast-iron.

's The founder's work is all cast metal, such as for ornamental gates and railings, rain-water pipes, cistern heads, and other portions, guttering, stable-fittings, coal-plates, &c. These commonly require to be fitted and fixed by the smith. The founder supplies all fire-grates, stoves, and other apparatus for warming and also for ventilation.

g. The gasfitter is a smith who supplies and fixes cast-iron pipes for diameters above two inches, and wrought iron for those of smaller bore, where gas is required to be used. A three-quarter inch pipe is considered by some as the least size to be used even for supplying rooms on an upper story; tin or composition metal pipes are fixed for sizes under half an inch, and also flexible tubes. It is recommended that no pipes should be embedded in the plastering, as is usually the case. In Paris the gas pipes must be seen for their whole length, and where passing through a floor or partition they must be let through a larger pipe having both ends open. Lights should not be fixed within 36 inches beneath wood-work. The solar or sun light is one of the modern additions for lighting large halls, as well as for dwelling-rooms; the globe lights, and some others of the same kind, all assist also in ventilating the apartments by tubes carrying off the products of combustion, which tubes are ordinarily fixed in the thickness of the floor; and as the air therein is raised to a very high temperature, great precautions are required to prevent danger by fire to the timbers, and also where the tubes pass through the roof. The effect of continued hot air on wood is little understood by the public generally. The star light, an invention of the late Mr Owen Jones, consists of a number of jets placed either horizontally or slightly inclining upwards at the jets; this is productive of a pleasing and brilliant light. There are many varieties of gas burners, such as the one called a fish tail, from which the form of the flame is the worst as regards economical results; the bat's-wing is better, and the argand is the best. The latter is a metal ring, pierced with numerous small holes, which divide the flame and allow of the proper combustion of the gas. Besides the common metal burners, there are some made with a soapstone or other cap, to prevent corrosion; and one of the better class is Bronner's patent burner, into which the gas is admitted through a very small opening adapted for supplying only a certain quantity of gas per hour. The usual burners have a large opening up to where the gas is consumed, and hence a waste of it.

For publications relating to the smith and founder's trade, see the article IRON; also Brandon, *Analysis of Gothic Architecture*, 4to, 1847; Viollet-le-Duc, *Dict. Rais.*, s.v. Grille and Serrurerie; Wyatt, *Metal Work*, fol., 1852; Jousse, *La fidèle ouverture de l'art du Serrurerie*, fol., 1627; *L'Art du Serrurerie*, in *Description des arts et metiers*, fol., 1767; Fordrin, *Livre du Serrurerie*, fol., 1723; Cottingham, *Smith, Founder's, &c., Director*, 4to, 1823; Pugin, *Designs for Iron and Brass Work*, 4to, 1835; Shaw, *Examples of Ornamental Metal-Work*, 4to, 1825; Welldon, *The Smith's Right Hand*, 8vo, 1765; Leconte, *Choix de nouveaux modèles de Serrurerie*, fol., 1838; Scott, *Ornamental Designs*, fol., 1852; King, *Orfevrerie et ouvrages au moyen age*, fol., 1853–60; Tijou, *A New Booke of Drawings*, fol., 1693; Bordeaux, *Serrurerie du moyen age*, 4to, 1858; Bury et Hoyau, *Modèles de Serrurerie*, fol., 1826; Thiollet, *Modèles, &c.*, fol., no date; Lachave, *Balcons, &c.*, fol., 1864; Normand, *Œuvres, &c.*, fol., 1824.

HOUSE-PAINTING.

The real object of painting is to protect wood, metals, and stuccoes from the action of the atmosphere, by covering them with a material which is capable of resisting it. A continued succession of moisture and dryness, and of heat and frost, soon effects the decomposition of woods, causes oxidation in most of the metals used for economic purposes, and destroys the generality of stuccoes if their surfaces be exposed nakedly to it. A solution of ceruse or white lead in linseed oil spread over them prevents these injuries in a great measure, and for a considerable period of time; and as the application of such an unction can be repeated without much trouble or expense as often as occasion may require, it may be said to furnish a protection against the contingencies named. In addition to the utility of painting, it is also available as an ornament, by bringing disagreeably or diversely coloured surfaces to a pleasing and uniform tint, or by diversifying a disagreeable monotony of tint, to suit the taste and fancy; and this is done in a great measure by the addition of various pigments to the solution before mentioned.

The painter works with brushes of various sizes, made Tool of hog's bristles, or of hair with a mixture of bristles, and pencils made of badger's hair; these, with the addition of pots to hold his colours, a grinding-stone and grinder or muller for grinding or triturating them, a pallet and a pallet knife, dusting brushes and a scraping knife for cleaning iron-work before repainting, are almost his only implements. In painting the outside of windows he sometimes uses the glazier's horse. His materials are comparatively few also; but for some purposes these require a great variety of ingredients, the preparation and combination of which, however, now devolves principally on the manufacturer or colourman, and not on the painter himself. The colours are ground with a muller, which Colo is worked on the stone until they become a very fine powder; with some, the more they are ground the better is the colour. The powder is moistened with a little water or oil, as necessary, from time to time. They should all be ground separately; it is not good to produce a tint by mixture until they are well prepared. Only the quantities necessary for the work undertaken should be got ready. Common colours are those which are produced by the addition to white lead (or zinc white) and oil of lamp-black, red lead, or any of the common ochres; blues, greens, rich reds, pinks, and yellows, &c., being more costly, are taken as such. Unflatted white is a common colour; flatted it classes with the rich colours. If the same surface be painted of two different tints, it is said to be in party colours. The substance generally constituting nine-tenths of the body of paint is carbonate of lead, commonly called white lead, the quality of which is therefore of the greatest importance.

to the durability of the work. It is said to improve by being kept for several years before use. Three qualities are manufactured, and there are six or more chief modes of adulteration recorded, which accounts in some measure for the great difference in painters' prices, and the relative values of their work when done. The other metallic white paint occasionally used, especially in water colour painting, is zinc white. It is well known for its intense whiteness, its resistance to sulphurous and other deteriorating causes, and its harmless qualities to the workman and the inmates of the house under decoration. Zinc white possesses less body than white lead, and great care is requisite that the colour when ground in oil is of sufficient consistence to be laid on a flat surface without showing through; any oil in excess will form a slight glutinous coating on the surface, retaining every particle of dust brought in contact with it, until it has evaporated. In general this white does not dry so quickly as the other colour, but this defect is remedied by the application of proper drying oils. It is asserted that in consequence of the great durability of the colour, the paint may be washed for a succession of three, four, and even five years; and that after each successive washing the surface will be found as clear and bright as when fresh painted.

ng work. In painting or laying on the colour, the brush must be constantly at right angles to the face of the work, only the ends of the hairs, in fact, touching it, for in this manner the paint is at the same time forced into the pores of the wood and distributed equally over the surface. If the brush be held obliquely to the work, it will leave the paint in thick masses wherever it is first applied after being dipped for a fresh supply into the pot, and the surface will be daubed, but not painted. Painting, when properly executed, will not present a shining, smooth, and glossy appearance, as if it formed a film or skin, but will show a fine and regular grain, as if the surface were natural, or had received a mere stain without destroying the original texture. Imitative grainings, however, and the varnishes which are intended to protect them, and make them bear out, necessarily produce a new and artificial texture; and for this reason some consider them to a greater or less extent disagreeable, however well the imitations may be effected. Carved mouldings and other enrichments have to be picked out with a pencil or small brush, that the quirks, &c., be not choked up.

As it must be presumed that all the wood submitted to the operations of a painter, which has passed through the hands of the joiner, is already well seasoned and properly dry, it is only necessary to say generally, that the work should be free from moisture of any and every kind before paint is applied to it, or it will at the least prove useless, and probably injurious rather than beneficial. This remark applies alike to wood and to plastered work, both internal and external; that is, whether they be subjected to the more violent changes of the weather or not. Dampness or moisture in woods, stopped in or covered up with paint, will, under ordinary circumstances, tend to their destruction; and in stuccoes it will spoil the paint, and most probably injure the plastering itself also. The first thing the workman has to attend to in painting new wood-work is to prepare its surface for the reception of paint, by counteracting the effect of anything that may tend to prevent it from becoming identified with the ma[illegible]. Thus, in painting pine-woods, the resin in the knots which appear on the surface must be neutralized, or a blemish will appear in the finished work over every resinous part. In best work the knots should be cut out to a sligth depth at the bench, and the holes filled up with a stiff putty made of white lead, japan, and turpentine. The next best way is to cover them with gold or silver leaf. The usual method is to cover them with a size knotting, which is a preparation of red lead, white lead, and whitening made into a thin paste with size. The common coating of red ochre is worth nothing.

Coats of paint. The next process is that of priming, which consists in giving a coat of white lead with red lead and a little drier in linseed oil. This is the first coat, upon which the look of the finished work much depends. Inequalities or unevennesses of surface must be reduced with sand-paper or pumice-stone, or made up with putty. The necessary process for killing knots will generally leave a film, which must be rubbed down; and the heads of nails and brads having been punched in, will present indentations, which should be stopped, as well as any cracks or other imperfections, with putty. A second coat is then given, consisting of white lead and linseed oil. It should have a good body, and be laid even. This coat, when thoroughly dry, is in best work rubbed down with fine sand paper and carefully examined to ascertain if any further stopping be required; and then the third coat or ground colour is applied, of a somewhat darker tint than wanted when finished, having sufficient oil for easy working, but not too fluid,—about two-thirds oil and one-third turpentine are used. The flatting coat follows, the object of which is to do away with the gloss or glaze of the oil, by obtaining a flat appearance. White lead is mixed with turpentine, with sometimes a little copal varnish; the colouring matter is added, but always lighter than the ground colour, or it would when finished appear in a series of shades and stripes. Flatting must be executed quickly, on account of the evaporation of the turpentine, and the brush is generally, if not always, carried up the wall and not across it. Some painters use a large quantity of turpentine in the several coats for quick work, as it dries more rapidly; but for good and lasting work no turpentine should be used. Flatted work is generally done only to best apartments, chief staircases, entrance halls, &c., and omitted in the upper rooms, in bedrooms, and in basements. All new wood-work should be painted a sufficient number of coats to "bear out" as it is called; this is a precaution against each coat being so much diluted with turpentine or other fluid as not to cover sufficiently, which is seen by a deadness in one part and a glaze in another. The priming coat and three others should be sufficient. Sometimes plaster and new wood are first done over with clearcole, which is white lead ground up in water and size added. This prevents absorption of the oil, but the paint added subsequently is apt to blister or to crack off; it therefore should not be allowed.

Painting or plaster. Plaster and stucco to be painted requires some care in the workmanship of it, as noticed under "Plaster-work," *supra*, to prevent bubbles, and must be quite dry. Some persons recommend a priming or a second coat of strong double size; the next coat then consists of white lead in oil as stiff as possible, and then another coat of size, and so on; but such work should be repudiated. A good first coat of priming, as much as the stucco will absorb, is essential.

Outside painting. All new outside work should be primed with red lead or litharge, mixed in linseed oil; the second coat is of the same mixture if four-coat work is to be done, and in this coat all defects are to be made good; the third and fourth coats, as may be determined upon, are generally of the tint required.

Old work. In painting old work, where two coats are generally considered sufficient, the surface must be well washed to get rid of all dirt and grease, and then rubbed down with pumice-stone to remove all inequalities. The work then receives one coat, after which any holes are stopped by the painter with putty; the second and perhaps a third

coat, or a flatting coat, are then applied. Sometimes each of the earlier coats is rubbed down.

Old ceilings and soffits of stairs are either washed to clean off the dirt and grease, stopped (which is cutting out the cracks and stopping them with new plaster), and whitened by a coat of whitening or Spanish white mixed with size; or after the two first operations they are finished in distemper, which is white lead and size; it presents a better appearance. Colouring is also done to plastered walls, the white being mixed in half linseed oil and half turpentine, and some earth added to make the tint required. Limewhiting is done by the bricklayer's labourer. Stucco or plaster-work, which is intended to be painted, but which is not sufficiently dry to receive the oil, may have a coating of water colours, or distemper colour, as it is called, in order to give a more finished appearance to that part of the building. The colour selected should be ground very fine, and incorporated with the whiting and parchment, or other strong size. Two coats will be required to make it bear out uniformly. When the stucco is sufficiently dry, and it is desired to be painted, the whole of the above colouring has to be washed off, and the painting proceeded with as described for new work.

Metal-work, not being absorbent, only requires when new to have a priming, and one, two, or three coats of oil paints, as may be considered necessary. It should have a coat as soon after it leaves the founder or smith as possible, to prevent early stages of oxidation. Old work should be cleaned, scraped, and filed if necessary, to remove rust, broken paint, and dirt.

Graining is understood among painters to be the imitating of the several different species of ornamental woods, as satin-wood, rose-wood, king-wood, air-wood, mahogany, wainscot or oak, and others. After the necessary coats of paint have been put on to the wood, a ground is then laid of Naples yellow and ceruse, diluted with turpentine if for satin-wood, which is left to dry. The painter then prepares small quantities of the same yellow and ochre with a little brown, and boiled oil and turpentine, and having mixed this, spreads it over some small part of his work. The flat hog's hair brushes being dipped in the liquid and drawn down the newly laid colour, the shades and grainings are produced. To obtain the mottled appearance, the camel's hair pencils are applied, and when completed the work is left to dry, and afterwards covered by a coat or two of good copal varnish. Imitation wainscot requires the use of combs of various degrees of fineness to obtain the grain (whence the process is called *combing* by some persons), and the flower is got by wiping off the colour with a piece of rag. When dry it is over-grained to obtain a more complete representation of the natural wood, and then varnished. If the work be done in water colour and not in oil, beer grounds to act as a drier are mixed with the colour, this sets it ready for varnishing. A "patent graining-machine," a sort of roller with a pattern upon it, has lately been introduced. The writer of this article suggested some years ago that deal well sized to prevent absorption might be at once grained either wainscot or pollard oak, without the preliminary operation, delay, and smell of painting. When dry it is to be varnished as usual. The effect is somewhat better than that obtained by the usual method of graining.

Marbling is the imitation of real marbles, granites, &c., some of which are represented by splashing on the carefully prepared ground, which should have been painted and often rubbed and polished to obtain an even surface; others have to be painted in colours, and then well varnished. The most expert at this sort of imitation do their work so as to prevent its easy detection except by the touch.

Ornamental painting embraces the execution of friezes and the decorative parts of architecture on walls and ceilings in chiaroscuro (or light and shade) or monochrome colouring. The ground is well prepared, and of the tint of the proposed work; the ornament and figures are drawn upon it, and are then painted and shaded to give them their due effect. This kind of work is sometimes painted on cloth and then fastened up. When the ornamental work is of a similar pattern throughout, as mouldings, fretwork, a running ornament, &c., it is effected by stencilling. This method consists in drawing a certain length of the pattern on paper, which is pricked through with a large sized needle, then laid on the wall to be ornamented, and struck with a small linen bag containing powdered chalk; the chalk enters the apertures, and fixes itself against the paint. The painter then draws it, or fills in the pattern with colours. Another method is to cut out the pattern where possible, and the paper, being stiffened with size, is laid on the surface, and a brush filled with the colour passed over it; the paper is carefully removed and laid on a fresh place, and so on. The pattern may then be touched up when dry with another tint, or with gold, or another pattern with minuter detail laid on it, and the operation repeated. A wall surface may be covered with such an ornamentation, of which paper hangings are a cheap substitute.

Many of these methods of decoration having been styled shams, the promoters of real woods advocated the disuse of paints, &c. This has led to the increased use of deals and pines for inside doors, wainscots, linings, shutters, and the like, which, if not left as completed by the tradesmen, are sized and varnished or polished. But in such a case a good selection of the wood is necessary, and it has to be picked. Another method is to stain the timber, as of roofs, galleries, and the like, or the joiners' work, so that it represents various tints of oak, and this is protected by a coat or two of varnish. These systems are open to the objection that the varnish, especially in towns, darkens rapidly, and every coat of it adds to the defect, so that in a few years paint is required to give the work the clean and lively appearance the wood originally possessed. Real wainscot, mahogany, and other woods are usually polished; the first is sometimes varnished after being properly prepared to prevent the rise of the grain which occurs when it is touched by a liquid.

Varnishing having been frequently referred to, we must notice that there are many varieties useful for various purposes. Like white lead, oil, and turpentine, they are subject to much adulteration, whereby the work is deprived of its proper consistency, and the painter and his employer dissatisfied with the result. There are drying varnishes made with spirit of wine; these are applied to some furniture, mouldings, &c. Varnishes made with essential oils, especially those made with oil of turpentine or ether and pure copal, are very solid, and better than those made with fat drying oils, which, from their colour being dark, are used only with grounds of a dark colour. Varnish can sometimes be tinted to correct defects of colour in graining, &c. For wood-work copal varnish in oil should alone be used.

It is not within our province to enter upon the higher class of painting on walls, which comes under the trade of the decorator, including that of the gilder and the artistic draughtsman and colourist, nor upon the higher class of paper-hangings. Decorations must necessarily depend upon the taste and skill required or employed in producing them. Paper-hangings are paid for by the piece or yard, a piece being made in England twelve yards long and twenty inches wide, and the hanging is charged at so much the piece. A dozen of borders is twelve yards long; they are charged by the yard for the material, and by the dozen for hanging. Sizing and otherwise preparing the

walls may be requisite before hanging the papers; and washing old papers from off the walls should always be insisted upon by the owner of a house, as accumulations of paste, colours, and size are apt to breed vermin, and, as some think, to give rise to fevers. French paper-hangings are only eighteen inches wide and nine yards long. Wood-linings, old panelled wainscoting, and other irregular surfaces, require to be canvased and papered before the decorative paper is hung, otherwise it is liable to crack with the shrinking of the wood.

The principal publications on house painting are as follows:—Tingry, *Painter's and Varnisher's Guide*, 8vo, 1832, 3d edit.; Higgins, *Painter's and Decorator's Companion*, 4to, 1841; Arrowsmith, *House Decorator's and Painter's Guide*, 4to, 1840; Field, *Rudiments of the Painter's Art*, 12mo, 1850, and his *Chromatography*, 4to, 1841; Smith, *The Art of House Painting*, 12mo, 1687, improved by W. Butcher, 8vo, 1821; Whittock, *Decorative Painter's Guide*, 4to, 1841; Moxon, *Grainer's Guide*, 1842; Barber, *Painter's Assistant*, 12mo, 1852; *Wood and Marble Imitator's Manual*, 8vo, Edinb. There are two or three French journals which give examples of imitations of woods and marbles, and illustrations of decorations for apartments. (W. P.)

INDEX OF PRINCIPAL SUBJECTS.

Legal definition. BUILDING SOCIETIES, or societies "for the purpose of raising, by the subscriptions of the members, a stock or fund for making advances to members out of the funds of the society upon freehold, copyhold, or leasehold estate by way of mortgage," may be "either terminating or permanent" (37 and 38 Vict. c. 42, § 13).

A "terminating" society is one "which by its rules is to terminate at a fixed date, or when a result specified in its rules is attained;" a "permanent" society is one "which has not by its rules any such fixed date or specified result, at which it shall terminate" (§ 5).

Popular definition. A more popular description of these societies would be,—Societies by means of which every man may become "his own landlord," their main purpose being to collect together the small periodical subscriptions of a number of members, until each in his turn has been able to receive a sum sufficient to aid him materially in buying his dwelling-house.

Origin. The origin and early history of these societies is not very clearly traceable. A mention of "building clubs" in Birmingham occurs in 1795; one is known to have been established by deed in the year 1809 at Greenwich; another is said to have been founded in 1825, under the auspices of the earl of Selkirk at Kirkcudbright in Scotland, and we learn (Scratchley *On Building Societies*, p. 5) that similar societies in that kingdom adopted the title of "menages."

Acts of 1834 and 1836. When the Friendly Societies Act of 1834 gave effect to the wise and liberal policy of extending its benefits to societies for frugal investment, and generally to all associations having a similar legal object, several building societies were certified under it,—so many, indeed, that in 1836 a short Act was passed (6 and 7 Will. IV. cap. 32), confirming to them the privileges granted by the Friendly Societies Act, and according to them the additional privileges (very valuable at that time) of exemption from the usury laws, simplicity in forms of conveyance, power to reconvey by a mere endorsement under the hands of the trustees for the time being, and exemption from stamp duty. This Act remained unaltered till 1874.

The early societies were all "terminating,"—consisting of a limited number of members, and coming to an end as soon as every member had received the amount agreed upon as the value of his shares. Terminating societies.

Take, as a simple typical example of the working of such a society, one the shares of which are £120 each, realizable by subscriptions of 10s. a month during 14 years. Fourteen years happens to be nearly the time in which, at 5 per cent. compound interest, a sum of money becomes doubled. Hence the present value, at the commencement of the society, of the £120 to be realized at its conclusion, or (what is the same thing) of the subscriptions of 10s. a month by which that £120 is to be raised, is £60. If such a society had issued 120 shares, the aggregate subscriptions for the first month of its existence would amount to exactly the sum required to pay one member the present value of one share. One member would accordingly receive a sum down of £60, and in order to protect the other members from loss, would execute a mortgage of his dwelling-house for ensuring the payment of the future subscription of 10s. per month until every member had in like manner obtained an advance upon his shares, or accumulated the £120 per share.

As £60 is not of itself enough to buy a house, even of the most modest kind, every member desirous of using the society for its original purpose of obtaining a dwelling-house by its means would require to take more than one share. In this respect the Act of 1836 presented a curious inconsistency; it limited the amount of each share to £150, and the amount of the monthly contributions on each share to £1, but did not limit the number of shares a member might hold. If its purpose in this respect was to confine the operation of these societies to the industrial classes, it was defective. The only rational explanation of the provision is that it was an anticipation of the modern system of limited liability.

The earlier formed societies (in London at least) did not usually adopt the title "Building Society;" or they added to it some further descriptive title, as "Accumulating Fund," "Savings' Fund," or "Investment Association." Several are described as "Societies for obtaining freehold property." Names of societies.

or simply as "Mutual Associations," or "Societies of Equality." The building societies in Scotland are mostly called "Property Investment Companies," or by some similar name. Although the term "Benefit Building Society" occurs in the title to the Act of 1836, it was not till 1849 that it became in England the sole distinctive name of these societies; and it cannot be said to be a happy description of them, for as ordinarily constituted they undertake no building operations whatever, and merely advance money to their members to enable them to build or to buy dwelling-houses or land.

The name "Building Society," too, leaves wholly out of sight the important functions these societies fulfil as means of investment of small savings. The Act of 1836 defined them as societies to enable every member to receive the amount or value of a share or shares to erect or purchase a dwelling-house, &c., but a member who did not desire to erect or purchase a dwelling-house might still receive out of the funds of the society the amount or value of his shares, improved by the payments of interest made by those to whom shares had been advanced.

ιanent ties. About 1846 an important modification of the system of these societies was introduced, by the invention of the "permanent" plan, which was adopted by a great number of the societies established after that date. It was seen that these societies really consist of two classes of members; that those who do not care to have, or have not yet received, an advance upon mortgage security are mere investors; and that it matters little when they commence investing, or to what amount, while those to whom advances have been made are really debtors to the society, and arrangements for enabling them to pay off their debt in various terms of years, according to their convenience, would be of advantage both to themselves and the society. By permitting members to enter at any time without back-payment, and by granting advances for any term of years agreed upon, a continuous inflow of funds, and a continuous means of profitable investment of them, would be secured. The interest of each member in the society would terminate when his share was realized, or his advance paid off, but the society would continue with the accruing subscriptions of other members employed in making other advances.

istics. Under this system Building Societies have largely increased and developed. In the county of Middlesex alone, 1600 societies were certified between 1836 and 1874; in that of Lancaster, 1300; and the total number of societies established in England and Wales cannot be less than between 5000 and 6000.

Deducting the terminating societies which have reached their termination, and the permanent societies which have failed or been dissolved, it is estimated that more than 2000 societies are still in existence. The operations of some of these societies are very extensive. The Queen's Building Society at Manchester has an income of £734,578, and assets amounting to £910,224; a society at Halifax has an income of £261,654, and assets £430,683; one at Burnley £221,508 income, and £324,919 assets (*Report of Registrar*, 1875). There are also several large societies in Scotland.

The total funds and income of building societies cannot be accurately ascertained; but the Royal Commissioners who inquired into the subject in 1872, estimated the total assets of the societies in 1870 at 17 millions, and their annual income at 11 millions. The larger societies are in the North of England, where, indeed, all classes of provident associations, notably friendly societies and co-operative societies, are more fully developed than in the South. To this remark, however, there is one exception, viz., the Birkbeck Building Society, London, whose receipts for the year 1874 amounted to 4½ millions, but by far the larger portion of that enormous sum consisted of deposits paid to the society as a banker.

arr Bow- ett cieties. A variety of the terminating class of societies has met with some favour of late years, under the name of "Starr Bowkett" or "mutual" societies, of which about 200 have been established. They differ from the typical society above described, in the contribution of a member who has not received an advance being much smaller, while the amount of the advance is much larger, and it is made without any calculation of interest. Thus a society will issue say 500 shares, on which the contributions are to be 1s. 3d. per week, and, as soon as a sum of £300 has accumulated, will allot it by ballot to one of the shareholders, on condition that he is to repay it without interest by instalments in 10 or 12½ years, and at the same time to keep up his share-contributions. The fortunate recipient of the appropriation is at liberty to sell it, and frequently does so at a profit; but (except from fines) no profit whatever is earned by those who do not succeed in getting an appropriation, and as the number of members successful in the ballot must necessarily be small in the earlier years of the society, the others frequently become discontented and retire. These societies cannot, of course, borrow money, for as they receive no interest they cannot pay any. The plan has recently been modified by granting the appropriations alternately by ballot and sale, so that by the premiums paid on the sales (which are the same in effect as payments of interest on the amount actually advanced) profits may be earned for the investing members.

A further modification of the "mutual" plan is to make all the appropriations by sale. The effect of this is to bring the mutual society back to the ordinary form; for it amounts to precisely the same thing for a man to pay 10s. a month on a loan of £60 for 14 years, as for him to borrow a nominal sum of £84 for the same period, repayable in the same manner, but to allow £24 off the loan as a "bidding" at the sale. The only difference between the two classes of societies is that the interest which the member pays who bids for his advance depends on the amount of competition at the bidding, and is not fixed by a rule of the society. Appro tions b sale or

In 1874 an Act was passed at the instance of the building societies conferring upon them several valuable privileges, and relieving them of some disabilities and doubts, which had grown up from the judicial expositions of the Act of 1836. Building societies are now incorporated bodies, and the members, and all who derive title through them, henceforth will not have to trace that title through a succession of trustees for a society. Again, a distinct declaration is given to the members of entire freedom from liability to pay anything beyond the arrears due from them at the time of winding up, or the amount actually secured by their mortgage deeds. Power to borrow money is also expressly given to the societies by the Act, but upon two conditions:—that the limitation of liability must be made known to the lender, by being printed on the acknowledgment for the loan, and that the borrowed money must not exceed two-thirds of the amount secured by mortgage from the members, or, in a terminating society, one year's income from subscriptions. Act of 1874.

Previous to the passing of the Act (or rather to the judicial decision in *Laing* v. *Read*, which the clause of the Act makes statutory) there had been, on the one hand, grave doubts on high legal authority whether a society could borrow money at all; while, on the other hand, many societies in order to raise funds carried on the business of deposit banks to an extent far exceeding the amounts used by them for their legitimate purpose of investment on mortgage. It is now enacted, that if a society borrow more than the statute authorizes, the directors accepting the loan shall be personally responsible for the excess.

The history of building societies thus briefly traced shows great progress in the past and equal promise for the future. The social and moral utility of societies established for the direct purpose of aiding a man to become proprietor of his dwelling-house is obvious, and the extent to which that purpose has been effected is very considerable.

It may be mentioned that building societies flourish in America (notably in Massachusetts, where they are called "Mutual Loan Fund Associations," and Pennsylvania), and in the British colonies, especially that of Victoria, Australia. (E. W. B.)

BUITENZORG, the capital of an assistant-residency in the island of Java, is situated in 6° 37′ S. lat. and 106° 52′ E. long., and is 66 miles S. of Batavia, with which it has been connected by rail since 1872. Lying 830 feet above the level of the sea, and possessing a salubrious climate, it is becoming a favourite place of residence for the Dutch of the greater city. Its principal buildings comprise the new church, which serves both for Protestant and Roman Catholic worship, a mosque, the regent's mansion, excellent barracks for the garrison, a prison, built in 1848, a bathing establishment, and the country palace of the governor-general. This splendid edifice occupies the site of the old castle, which was founded in 1744 by Baron van Imhof, enlarged by Daendels in 1809, restored by Van der Capellen in 1819, and destroyed by an earthquake in 1834. The botanical gardens, laid out in 1817 by Van der Capellen, are among the finest and most extensive in the world. In

the neighbourhood of Buitenzorg is Batton-Toulis-Cocabatou, a sacred wood held in high veneration by the natives.

BUJALANCE, a town of Spain, in the province of Cordova, and about 25 miles E. of that city. It contains a Moorish castle flanked with towers, two hospitals, a foundling asylum, and a seminary for the education of girls. Leather and woollen cloth are manufactured. Population 8946.

BUKOWINA, a duchy and crown-land of the Austrian empire, bounded on the N. and N.W. by Galicia, W. by Hungary and Transylvania, S. by Moldavia, and E. by Moldavia and Russia. It has an area of 4036 English square miles, and the population in 1869 amounted to 511,964, of whom 255,919 were males and 256,045 females. The country, especially in its southern parts, is largely occupied by offshoots of the Carpathian mountains. Its northern border is skirted by the Dniester, and a considerable section is drained by the Pruth, but by far the larger portion belongs to the system of the Danube, and is watered by the head streams of the Sereth, the Moldava, and the Bistritza. The climate is healthy but severe, especially in winter; and the soil, particularly in the north, is of great fertility. A large part of the surface,—according to official statistics in 1870, no less than 1,050,849 acres, or nearly one-half of the whole,—is occupied by woodland; and the very name of the country is derived from the abundance of beech-trees. Wheat, rye, oats, maize, barley, beans, potatoes, flax, and hemp are all more or less cultivated; and about 643,319 acres of arable land are under tillage. Gardens and meadows occupy 301,706 acres, vineyards 11, and pasture 290,531. In 1870 the number of horses in the duchy was 42,649, cattle 224,424, sheep 217,913, goats 18,786, and swine 133,385, while the bee stocks amounted to no fewer than 27,091. The mineral productions comprise copper, iron, lead, silver, coal, salt, sulphur, and alabaster, some of which, however, are only yielded in very moderate quantities. In 1870 the iron ore obtained amounted to 5808 tons, the copper to 945, and the salt 2590. The principal mineral springs are at Dorna-Watra, Jakobeny, and Lopuszna, but none of them as yet are much frequented. The country is divided into the eight districts of Czernowitz, Kimpolung, Kotzmann, Radautz, Sereth, Storozynec, Suczawa, and Wisznitz, the capital Czernowitz forming a separate and ninth division. There are seven towns in all, eight market-villages, and 456 hamlets, the most populous places being Czernowitz with 33,884 of a population, Radautz 9429, Suczawa 7450, Sereth 6486, Kuszusmare 6419, and Kimpolung 5561. Industrial activity is still comparatively slight, the most important establishments being the breweries, of which there were fifteen in 1870, and the distilleries, which numbered forty-nine. The population is of various origin,—about 180,000 being Roumanians, 200,000 Ruthenians, and the rest Germans, Poles, Jews, Hungarians, &c. The German language alone is used in twenty-one of the village schools, and Roumanian in forty-nine, while in many both are in use. In 1869 there were 376,946 adherents of the Greek church, 74,347 Catholics, 11,393 Protestants, and 47,772 Jews, the total population amounting to 511,964, while in 1857 it was only 456,920. The Bukowina diet consists by the law of 1861 of thirty members, including, besides the bishop, ten appointed by the landed proprietors, seven by the towns, and twelve by the rural communes. Five members are sent to the imperial diet. Originally a part of Transylvania, Bukowina, passed in 1482 to Moldavia, and in 1775 to Austria, who united it in 1786 as the Czernowitz circle with Galicia, but in 1849 raised it to its present independence

BULACAN, the chief town of a province of the same name in the Philippine island of Luzon, situated on an arm of the Pampanga delta, about 15 miles N. of Manila. With the exception of the churches and a few stone buildings, it was completely destroyed by fire in 1859, but has since been rebuilt. Population estimated at about 10,000.

BULANDSHAHR, a district of British India, in the Meerut division, under the jurisdiction of the Lieutenant Governor of the N.W. Provinces; lies between 28° 3′ and 28° 43′ N. lat., and 77° 28′ and 78° 32′ E. long. It is bounded on the N. by the district of Meerut; on the E. by the districts of Moradabad and Budaun; on the S. by the district of Alígarh; and on the W. by the districts of Gúrgáon and Delhi. The district stretches out in a level plain, with a gentle slope from north-west to south-east, and a gradual but very slight elevation about midway between the Ganges and Jumna. Principal rivers, the Ganges and Jumna,—the former navigable all the year round, the latter only during the rains; minor rivers, Hindan and East Kálí Nadí, not navigable. The Ganges canal intersects the district, and serves both for irrigation and navigation. Area of Bulandshahr district, 1910 square miles, of which 1368 are under cultivation; 346 cultivable, but not actually under cultivation; and the rest uncultivable waste. Population in 1872, 936,593 souls, residing in 182,694 houses, and inhabiting 1566 villages; persons per square mile, 490; per village, 598; per house, 5·1. Of the total population 760,602 or 81·2 per cent. were Hindus; 175,900 or 18·8 per cent. Mahometans; and 91 Christians and others.

Cotton, indigo, sugar, wheat, tobacco, barley, millet, and various kinds of pulse, form the principal agricultural products. The chief traffic routes are—(1), Road from Meerut to Alígarh; (2), from Delhi to Bareilly; and (3), between Delhi and Anúpshahr. The East Indian Railway passes through the district. Total revenue in 1870–71, £176,422, of which £155,675, or 88 per cent., was from land. The regular constabulary police consisted of 523 men in 1870–71, besides the rural or village watch. Bulandshahr district contained 302 schools in 1872–73, attended by 6959 pupils. The following twelve towns in the district have upwards of 5000 inhabitants:—1. Baran or Bulandshahr, the administrative headquarters, situated on the right bank of the Kálí Nadí, on the route from Bareilly to Delhi, in 28° 24′ N. lat. and 77° 56′ E. long.; area, 111 acres; population, 14,804; municipal income in 1872, £1075; expenditure, £1139, 2s.; rate of municipal taxation, 1s. 5⅝d. per head. 2. Dibai—area, 106 acres; population, 7782; municipal income, £346, 16s. 9d.; expenditure, £298, 7s. 4d.; rate of taxation, 10⅝d. per head. 3. Anúpshahr—area, 123 acres; population, 9336; municipal income, £598, 14s.; expenditure, £532, 14s.; rate of taxation, 1s. 3⅝d. per head. 4. Jahángírábad—114 acres; population, 9408; municipal income, £571, 3s. 5d.; expenditure, £456, 12s. 9d.; rate of taxation, 1s 2⅝d. 5. Shikárpur—area, 115 acres; population, 11,150; municipal income, £435, 19s. 6d.; expenditure, £408, 11s. 9d.; rate of taxation, 9⅝d. per head. 6. Dankaur—area, 251 acres; population, 5423; municipal income, £189, 2s. 4d.; expenditure, £163, 9s. 1d.; rate of taxation, 8⅝d. per head. 7. Jhajhar—area, 50 acres; population, 5632; municipal income, £241, 15s. 5d.; expenditure, £199, 2s. 9d.; rate of taxation, 10⅝d. per head. 8. Jewar—area, 78 acres; population, 7399; municipal income, £282, 14s. 4d.; expenditure, £233, 17s. 1d.; rate of taxation, 9½d. per head. 9. Siyána—area, 65 acres; population, 6268; municipal income, £294, 14s. 5d.; expenditure, £251, 9s. 4d.; rate of taxation, 11¼d. 10. Gulaothí—area, 44 acres; population, 5608; municipal income, £239, 0s. 8d.; expenditure, £223, 2s. 7d.; rate of taxation, 10¼d. per head. 11. Khúrja—area, 206 acres; population, 26,858; muncipal income, £2301, 14s.; expenditure, £3028, 10s.; rate of taxation, 1s. 8⅝d. per head. 12. Sikandarabad—area, 199 acres; population, 18,349; municipal income, £988; expenditure, £539, 10s.; rate of taxation, 1s. 0¾d. per head. The climate of the district is liable to extremes, being very cold in the winter and excessively hot in the summer.

Towards the end of the last century, the district passed into the hands of Perron, a French common sailor, who had won his way up to the rank of a general in the Marhattá service. Its annexation formed one of the leading points in the Marquis Wellesley's policy, and it was ceded to us by the Scindia treaty of 1803. Bulandshahr enjoyed a bad conspicuousness in the mutiny of 1857, when the Gujar peasantry plundered the towns.

there are 4,000,000 in the Turkish empire, and Professor Szabo makes their number in Servia 100,000. As early as the 14th century emigration took place to the Banat, where the Bulgarians number upwards of 23,000; and in Transylvania there is a colony which retains its dialect. (See *Denkschriften d. Wien. Akad., Phil.-hist. Cl.*, 1856.) Much more important are the Bulgarian settlements in Bessarabia, which in 1862 numbered 70,000 inhabitants. These began to be formed as early as 1787, and received strong accessions from 1801 to 1812. The chief town which owed its existence to this transmigration is Bolgrad, on Lake Yalpuk, which passed with a portion of Bessarabia to Moldavia in 1851. About 1865 it had 9000 inhabitants.

For further information the reader may consult Jochmus's "Journey into the Balkan in 1847" (*Jour. R. Geog. Soc.*, 1854); Frähn, in *Mém. de l'Acad. de St Petersbourg*, série vi. tom. i.; Lejean, *Ethnographie de la Turquie d'Europe*, 1861; St Clair and Brophy, *Residence in Bulgaria*, 1869; Tozer, *The Highlands of Turkey*, 1869; Sax, "Skizze von Bulgarien," in *Mittheil. der K. K. Geogr. Gesellsch. in Wien*, 1869; Kanitz, *Serbien, Hist.-ethnogr. Reisestudien*, 1868, and *Donau-Bulgarien und der Balkan*, 1875; Bradaska, "Die Slaven in der Turkei" (*Petermann's Mittheil.*, 1869, xii); R. Rösler, *Romänische Studien*, 1871.

BULGARIN, Thaddäus (1789–1859), a distinguished Russian writer, was born in Lithuania. His father was an officer under Kosciusko in the last disastrous Polish campaign. By some influence of friends Thaddäus was entered at the college for military cadets at St Petersburg, and afterwards received a commission in the Russian army, with which he served against Napoleon and in Finland. He then left the Russian army, joined the Poles under Napoleon, and took part in nearly all the great campaigns in Spain, Germany, and Russia. After the fall of the emperor he took up his residence in Warsaw, and devoted himself to literature, writing in his native Polish language. In 1819 he removed to St Petersburg, learned Russian, and became Russian in every way. He edited, alone or in conjunction with Gretch, the *Northern Archives*, the *Northern Bee*, and the *Russian Thalia*. In 1829 his first novel, *Ivan Vuizhagen*, gained great popularity. A continuation was afterwards published under the title *Peter Ivanovitch Vuizhagen*. His other works comprise two novels, *Demetrius* and *Mazeppa*, an *Account of Russia* (Russia in an historical, statistical, geographical, and literary point of view), and his *Reminiscences*. An English translation of his best novel, *Ivan Vuizhagen*, was published in 1831.

BULGARUS, the most celebrated of the famous "Four Doctors" of the law school of Bologna. He is sometimes erroneously called Bulgarinus, which was properly the name of a jurist of the 15th century. Bulgarus was a native of Bologna, and was regarded as the Chrysostom of the Gloss-writers, being frequently designated by the title of the "Golden Mouth" (*os aureum*). The time of his birth is not known. A popular tradition represents him to have been a pupil of Irnerius, but unfortunately nothing is known of Irnerius after 1118 A.D. Bulgarus, on the other hand, died in 1166 A.D., having attained a great age, and having become childish before his death. There is thus no inseparable difficulty in point of time in accepting this tradition as far as regards Bulgarus, although Savigny considers the general tradition to be inadmissible which represents all the Four Doctors to have been pupils of Irnerius. Martinus Gosia was the next most celebrated of the Four Doctors. He and Bulgarus were the chiefs of two opposite schools at Bologna, corresponding in many respects to the Proculians and Sabinians of Imperial Rome, Martinus being at the head of a school which accommodated the law to what his opponents styled the equity of "the purse" (*æquitas bursalis*), whilst Bulgarus adhered more closely to the letter of the law. The school of Bulgarus ultimately prevailed, and it numbered amongst its adherents Joannes Bassianus, Azo, and Accursius, each of whom in his turn exercised a commanding influence over the course of legal studies at Bologna. Bulgarus took the leading part amongst the Four Doctors at the diet of Roncaglia in 1158, and was one of the most trusted advisers of the Emperor Frederick I. His most celebrated work is his commentary *De Regulis Juris*, which was at one time printed amongst the writings of Placentinus, but has been properly reassigned to its true author by Cujacius, upon the internal evidence contained in the additions annexed to it, which are undoubtedly from the pen of Placentinus. Savigny considers this *Commentary*, which is the earliest extant work of its kind emanating from the school of the Gloss-writers, to be a model specimen of the excellence of the method introduced by Irnerius, and a striking example of the brilliant results which had been obtained in a short space of time by a constant and exclusive study of the sources of law.

BULL, Papal. See Bulls and Briefs.

BULL, George (1634–1710), bishop of St David's, was born at Wells, and educated at Tiverton school, Devonshire. He entered Exeter College, Oxford, but had to leave in consequence of his refusal to take the oath of allegiance to the Commonwealth. He was ordained privately by Bishop Skinner in 1655. The first benefice he enjoyed was that of St George's near Bristol, from which he rose successively to be rector of Suddington in Gloucestershire, prebendary of Gloucester, archdeacon of Llandaff, and in 1705 bishop of St David's. He died February 17, 1710. During the time of the Commonwealth he adhered steadily, though with great prudence, to the forms of the Church of England, and in the reign of James II. preached very strenuously against the errors of Romanism. His works are among the most solid contributions made to theological learning by the Church of England. They uniformly display great erudition and powerful thinking. The *Harmonia Apostolica*, published in 1670, is an attempt to show the fundamental agreement between the doctrines of Paul and James with regard to justification. The *Defensio Fidei Nicenæ*, his greatest work, published in 1685, tries to show that the doctrine of the Trinity was an article of faith in the Christian church before the Council of Nicæa. It still retains value as a thoroughgoing examination of all the pertinent passages in early church literature. The *Judicium Ecclesiæ Catholicæ* obtained for him the thanks of the French clergy. His last treatise, *Primitive and Apostolical Tradition*, was published shortly before his death. The best edition of his works is that in 7 vols., published at Oxford by the Clarendon Press, under the superintendence of the Rev. E. Burton. This edition contains the *Life* by Nelson. The *Harmonia, Defensio,* and *Judicium* are translated in the Library of Anglo-Catholic Theology.

BULL, John, a distinguished English composer and organist, was born in Somersetshire about 1563. In 1591 he was appointed organist in the Queen's chapel in succession to Blitheman, from whom he had received his musical education; in 1592 he received his degree of doctor of music at Cambridge University; and in 1596 he was made music professor at Gresham College, London. As he was unable to lecture in Latin according to the foundation-rules of that college, the executors of Sir Thomas Gresham made a dispensation in his favour by permitting him to lecture in English. He gave his first lecture on 6th October 1597. He afterwards visited France and Germany, and was everywhere received with the respect due to his talents. The story told by Anthony Wood of Dr Bull's feat at St Omer, which consisted in adding, within a few hours, forty parts to a composition already written in forty parts, is simply impossible. Honourable employments were offered to him by various Continental princes; but he declined them, and returned to England, where he was appointed organist to James I. in 1607, and in the same year resigned his Gresham professorship. In 1613 he again went to the Continent on account of his health; and, in the Netherlands, entered into the service of the archduke. In 1617 he was appointed organist to the cathedral of Nôtre Dame

at Antwerp, and he died in that city on the 12th March 1628. The usual statement that he died at an earlier date at Hamburg or Lübeck is incorrect. Little of his music has been published, and the opinions of critics differ much as to its merits. A claim made on his behalf to the composition of the music of the English national anthem has given rise to much discussion, but it seems now generally agreed that the claim is not well founded. Contemporary writers speak in the highest terms of Bull's skill as a performer on the organ and the virginals.

BULLA (literally a bubble) was the term used by the Romans for any boss or stud, such as those on doors, sword-belts, shields, &c. It was applied, however, more particularly to an ornament, generally of gold, worn suspended from the neck by children of noble birth until they assumed the *toga virilis*, when it was hung up and dedicated to the household gods. See COSTUME. In ecclesiastical and mediæval Latin, *bulla* denotes the metal seal of oval or circular form, bearing the name and generally the image of its owner, which was attached to official documents. The bulla of the empire was of gold, while the Papal bulla was of lead. See BULLS and BRIEFS.

BULLFINCH (*Pyrrhula vulgaris*), a species of conirostral bird belonging to the family *Fringillidæ*, of a bluish-grey and black colour above, and generally of a bright tile-red beneath, the female differing only in having its colours somewhat duller than the male. It is a shy bird, not associating with other species, and frequents well-wooded districts, being very rarely seen on moors or other waste lands. It builds a shallow nest composed of twigs lined with fibrous roots, on low trees or thick underwood, only a few feet from the ground, and lays four or five eggs of a bluish white colour speckled and streaked with purple. The young remain with their parents during autumn and winter, and pair in spring, not building their nests, however, till May. In spring and summer they feed on the buds of trees and bushes, choosing, it is said, such only as contain the incipient blossom, and thus doing immense injury to orchards and gardens. In autumn and winter they feed principally on wild fruits and on seeds. The note of the bullfinch, in the wild state, is soft and pleasant, but so low as scarcely to be audible; it possesses, however, great powers of imitation, and considerable memory, and can thus be taught to whistle a variety of tunes. Bullfinches are very abundant in the forests of Germany, and it is there that most of the piping bullfinches sold in this country are trained. They are taught continuously for nine months, and the lesson is repeated throughout the first moulting, as during that change the young birds are apt to forget all that they have previously acquired. The bullfinch is a native of the northern countries of Europe, occurring in Italy and other southern parts only as a winter visitor. White and black varieties are occasionally met with; the latter, it is said, on the authority of White of Selborne, may be produced by feeding the bullfinch exclusively on hemp-seed, when its plumage gradually changes to black. It breeds in confinement, and hybrids between it and the canary have been produced.

BULLINGER, HEINRICH (1504–1575), an eminent Reformer, was born at Bremgarten, near Zurich. He studied at Emmerich and Cologne, where he read some of Luther's works, and after his return home lectured at the abbey of Kappel. In 1527 he heard Zwingli at Zurich, and in the following year he accompanied him to the great conference at Berne. He was made pastor at Bremgarten in 1529, and married one Anna Adlischwegler, formerly a nun. In 1531 he had to fly to Zurich in consequence of the Catholic victory at Kappel, and was soon afterward appointed minister of the principal church. He was a powerful upholder of the Zwinglian doctrine of the Lord's Supper, and wrote an able defence against Luther. He had also numerous controversial writings against the Anabaptists. His printed works are very numerous, and many of them were translated into English. They form ten vols. folio. Bullinger died at Zurich in 1575.

BULLION is a term applied to the gold and silver of the mines brought to a standard of purity. The term is of commercial origin, and has reference to the precious metals as a medium of exchange. It followed from this office of gold and silver that they should approximate in all nations to a common degree of fineness; and though this is not uniform even in coins, yet the proportion of alloy in silver, and of carats alloy to carats fine in gold, has been reduced to infinitesimal differences in the bullion of commerce, and is a prime element of value even in gold and silver plate, jewellery, and other articles of manufacture. All the new gold and silver coinage of France, Germany, Spain, Italy, Belgium, and the United States—probably of a still wider circle of the principal coining countries in the world—contain nine-tenths of pure metal. The coinage of Russia is on the British standard of eleven-twelfths, as nearly as it can be expressed in simple fractions of pure gold and silver, the alloy in silver being a little more in all cases than the alloy in gold. Bullion, whether in the form of coins, or of bars and ingots stamped, is subject, as a general rule of the London market, not only to weight but to assay, and receives a corresponding value.

The recognition of gold and silver from the earliest times as a convenient means of purchase, their ultimate adoption as a prevailing standard of value, their coinage by all the richer states into pieces of money, in virtue of which their circulation and absorption have been immensely increased, and the extent to which they have become the necessary financial reserve of Governments, banks, trading companies, and merchants, have given to these metals a greatly more extended use and importance than they could have acquired in the ordinary process of arts and manufactures; though even in this latter sphere, as gold and silver become more abundant and communities richer, the purposes to which they are applied and the demand for them are susceptible of much expansion. Writers of high authority have attempted at various periods to estimate the production of gold and silver, and correlatively their use and consumpt in the monetary system and the arts; but there is scarcely any subject of statistical inquiry on which it is so difficult to arrive at more than conjectural results. Yet in view of the theoretical speculations that arose on the Californian and Australian gold discoveries, the produce of these new fields of supply may here be worthy of notice. The Californian mines were computed to have in three years yielded gold to the value of £35,000,000 sterling. The Australian mines, still more prolific, were estimated in three years from their opening to be equal to an annual produce of £20,000,000 sterling. Such results, sustained over a considerable period of years, presented a phenomenon similar to the more slowly developed effects of the discovery of the South American mines in the 16th century; and it must be admitted that California and Australia, after many reverses in their mining industry, remain the most gold-productive countries in the world. But their produce of bullion has of late years much fallen in amount.

The director of the United States' Mint, in his report for 1875, estimates the annual yield of gold and silver in California and other United States possessions at $100,000,000, or about £20,000,000. The total export of bullion and specie from Australia, after deducting the import (chiefly intercolonial), varied in the fifteen years 1858–1872 from 11¼ to 7½ millions sterling per annum the general tendency being towards the lower amounts in the later years (*Statistical Abstract for Colonial and*

other Possessions of United Kingdom, 1874). The annual average export in these fifteen years was £9,747,635, and must be held to measure amply the produce of the gold and silver mines of Australia. The annual production of bullion in the United States and Australia cannot, on these data, be estimated at more than 28 millions sterling. Humboldt found the annual produce of the gold and silver mines of America, Europe, and Northern Asia, at the beginning of the century, to be about £9,700,000. The yield of gold and silver from the same sources in 1850-57 was estimated by M'Culloch, in the *Commercial Dictionary*, to be £14,000,000. The old gold and silver mines can hardly have become more productive since the advent of the Californian and Australian diggings, so that it would appear the latter have increased the visible annual supply of gold and silver about threefold, or from £14,000,000 to £42,000,000. Japan, so far as can be judged from the exchanges, must now be added to the list of gold-producing countries. For several years in succession Japan has exported considerable and apparently increasing amounts of treasure, or gold and silver coins of its own mint. In 1874 this export amounted to $13,332,794, or nearly three millions sterling (Sir Henry Parkes's *Summary of Consular Reports*). During the first six months of 1875 the imports of bullion from Yokohama to London were £1,257,170 gold, £95,080 silver; and not improbably the next great access of the product of gold-mines may be from that part of the world. But notwithstanding this marked increase of gold and silver since 1850, when one considers the increase of population, the still greater increase of trade and industry, and the vast extension of financial and commercial affairs in the same period, it may be held doubtful whether gold and silver have lost any of their old proportion to the need for them and to the work they have to do.

When the coffers of the great banks of Europe were filled with the virgin gold of California and Australia, one of the first consequences was a desire on the part of countries in which silver was either a collateral standard of value with gold, or the sole standard of value, to discard the silver standard and adopt gold as the sole standard, involving in either case a large displacement of silver coinage and reserve, and a large infusion in its room of gold coinage and reserve. This result was exhibited in the mint operations both of France and England. In the former country silver retains its quality of legal tender in a modified degree; but the proportion of silver authorized by the Bank Charter Act of 1844 has long disappeared from the bullion reserve of the Bank of England, which now consists wholly of gold. It was one of the first resolutions of the German Empire, on the conclusion of the war of 1870-71, not only to make gold the sole standard, but to dislodge all the old silver money of the German States; and in the same connection it may be observed, that the director of the United States' Mint, in reporting £20,000,000 as the annual produce of the United States' mines, uses this fact as an argument for the immediate resumption of specie payment—or, in other words, that the American people, by a strenuous effort, should strive to keep as much of the bullion-product of their mines at home as may enable the whole currency of the Union to become either gold and silver, or of convertible gold value. This preference for the more precious metal as the sole standard of value, and for gold and silver coin as a medium of general circulation, may be expected to extend throughout the world in proportion as the produce of the mines may be increased; and in this respect alone there is a vast opening for the beneficial use both of gold and silver. It gives some idea of the immense service of bullion in the international exchanges, as well as in the replenishment of the internal metallic circulations, to observe that in the thirteen years 1858-70 the annual average registered import of gold and silver (real value) to the United Kingdom was £27,083,330, the average annual export £22,095,346; and that in the same thirteen years the average annual coinage of gold and silver in the Royal Mint was £4,854,661, or nearly equal to the annual excess of imports over exports of bullion, which flows in all this volume through London to and from every part of the globe—(*Statistical Abstract for United Kingdom*, 1872).

While the production of gold has declined of late years from the maximum attained after the Californian and Australian discoveries, the production of silver has begun to increase, and in the rapid development of minerals containing this metal, is generally expected to increase in the future. But it would seem premature from the facts of past experience to anticipate any permanent depreciation of the value of silver in relation to gold. The price of silver in the market of London from 1833 to 1873 ranged from 59d. to 62½d. per oz., and during that time fully maintained its standard value in par with that of gold—(*Table* of Messrs Pixley and Abell, bullion-brokers, London). But in the subsequent years a decline in the price of silver has occurred, and it fell in 1875 to 56d. per ounce. This may be the result of temporary causes, such as (1) the fact of £20,000,000 of German silver, displaced by the new gold coinage hanging over the market; and (2) a cessation of demand for India and China, which the exchanges of the East with Europe may at any time alter.

BULLS AND BRIEFS, Papal, are the two kinds of authoritative letters issued by the popes in their official capacity as head of the church, the bulls being the more important. They are distinguished from each other by several marks.

A *bull* is written on thick polished parchment, commonly in angular Gothic characters, and in Latin; it is always open; it commonly begins with the name of the Pope, but without adding any number (*e.g.*, Pius, not Pius IX.), then follows the term *episcopus*, then *servus servorum Dei*, then either the phrase *ad perpetuam rei memoriam*, or the greeting *in Domino salutem et apostolicam benedictionem*. It closes with the place and the date, which is commonly given according to the kalends, nones, or ides of the month and the year of the pope. The chief mark, however, of a bull is the seal. The popes use three kinds of seals—1, the signet-ring; 2, since the end of the 5th century, the *bulla*; 3, from the 13th century, the *annulus piscatoris*. A bull is sealed with the second, the *bulla*, and from this it derives its name. The *bulla* is a globular seal of lead; on the one side there is, in modern times, the heads of St Peter and St Paul, with the letters S. PE. and S. PA.; on the other side is the name of the Pope. Formerly the *bulla* often bore other impressions; the name of the Pope was always given, but sometimes the title *Papa* was impressed on the opposite side; sometimes a Scriptural image, such as the Good Shepherd. The popes evidently began to use this particular seal when, from the growing weakness of the empire, the temporal authority of the bishop of Rome began to be a real thing, and the popes assumed the consular dress and insignia; for the *bulla* had been used by the emperor of Constantinople, and its use was permitted to many of the great officers of state who were accustomed to act for the emperor. The *bulla* was the common imperial seal, and was used not merely by the emperors of the East, but also by the early German emperors, and even by some of the minor European sovereigns. It was sometimes made of gold, sometimes of silver, often of lead, and it was not until the earlier part of the Middle Ages that the leaden *bulla* became the distinctive mark of a Papal charter.

"Non auro, non argento, sacra Bulla refulget,
Insignit chartas plumbea forma sacras."

The word *bulla*—meaning first a bubble, then any kind of small ornament "*quasi inflata*," then a seal of a globular shape—came to be applied to a charter sealed with such a globular seal, and since the 15th century, exclusively to Papal letters of the first rank. If the bull is *in forma gratiosa* the seal is attached by threads of red and yellow silk; if *in forma rigorosa*, hemp is used. If the Pope issues a bull before he is enthroned, nothing is put on the seal, and the bull is commonly called *bulla blanca*. Before the time of Nicholas IV. such bulls were only valid if confirmed after enthroning. Since then they have been valid without confirmation. Consistorial bulls are issued after consultation with the consistory of cardinals, and are signed by all the cardinals consulted. Ducange (*Gloss. Med. et Inf. Lat.*) says that consistorial bulls are often sealed with the signet-ring.

A *brief* is not so important as a bull. It is written upon white paper, or thin parchment, in modern cursive characters, and is sometimes sent open, sometimes closed. It begins with the name of the Pope, then the title *Papa*, then the number of the Pope, then the phrase *ad perpetuam rei memoriam*, or *in Domino salutem et apostolicam benedictionem;* it ends with the name of the place, and the date (the day of the month, the year A.D., and the year of the Pope), and, finally, the words *sub annulo piscatoris*. The principal mark of the brief is its seal. It is sealed with red wax, with the signet called "the fisherman's ring," which dates from the 13th century, and bears a representation of St Peter fishing in a boat, and the name and the number of the Pope. The distinction between briefs and bulls is not much older than the 15th century. In the early Middle Ages the word *breve* was used to denote all sorts of *short* charters, and Ducange in his *Glossary* gives over a hundred different kinds of these. Papal bulls and briefs, like all other important legal instruments, are liable to be forged, and hence Roman Catholic jurists have made a special study of the various marks by which they are able to tell the age of a charter. The bulls and briefs of greatest importance have been published in *Bullaria* collections which have been put forth at different times under the authority of the church. The most important of those collections is the *Bullarium Magnum Romanum, a Leone Magno usque ad Benedictum XIV.*, Luxembourg, 1727–1758, 19 vols. fol., and its continuations.

BÜLOW, FRIEDRICH WILHELM (1755–1816), a Prussian general, was born at Falkenberg on the 16th February 1755. He entered the army at the age of fourteen, rose slowly, and in 1797 was placed at the head of a battalion. He took part in the campaigns of 1806–7, and in 1809 was made major-general and brigadier of infantry. On the renewal of the war against France in 1813 he took the field with the rank of lieutenant-general, was engaged in the battle of Möckern, and stormed the defences of Halle. He was victorious over Oudinot at Luckau and Grossbeeren, and over Ney at Dennewitz. He led the attack on the fortifications at Leipsic, and was conspicuous in the Prussian victory at Laon. To him also belonged the honour of closing the campaign by the capture of Montmartre. For his valuable services he was raised to the rank of general, and made Baron Dennewitz, with a handsome revenue. During the Hundred Days he commanded the fourth army corps, and by his rapid march contributed to Blücher's success at Waterloo. After the conclusion of the war he retired to Königsberg, where he died on the 25th February 1816.

BULWER, SIR HENRY LYTTON EARLE (1801–1872), statesman and diplomatist, created a peer, under the title of Baron Dalling and Bulwer, in 1871. See DALLING.

BULWER-LYTTON, SIR EDWARD GEORGE EARLE LYTTON (1805–73), brother of the preceding, created a peer, under the title of Baron Lytton, in 1866. See LYTTON.

BUNDELKHAND, an extensive tract, consisting partly of British districts and partly of native states, in the North-Western Provinces of India, lying between 23° 52′ and 26° 26′ N. lat., and 77° 53′ and 81° 39′ E. long. It is bounded on the N. by the Jumna, on the E. by the Bághalkhand or the Rewá state, on the S. by the Central Provinces, and the W. by the state of Gwalior.

It comprises the British districts of Hamírpur, Jalaun, Jhánsi, Lalatpur, and Bándá; the semi-independent states of Orchhá or Tehrí, Datiyá, and Samthar; and the following petty states held under grants from the British Government, viz.:—Ajegarh, Alípurá, Ashtgarhí Jágír, Tori-Fathpur, Bijná and Paharí Banká, Barondá, Báwaní, Berí, Bíhat, Bijáwar, Charkhárí, seven Chaubiyáná Kalinjár Jágírs, Chhatrapur, Garraulí, Gáuríhar, Jasú, Jigní, Khaniyá Dháná, Lughásí, Naigáon Ribahí, Panná, and Sarílá. Length of Bundelkhand—200 miles from S.E. to N.W.; breadth, 155 miles; area variously estimated from 18,099 to 23,817 square miles.

The surface of the country is uneven and hilly, except in the N.E. part, which forms an irregular plain cut up by ravines scooped out by torrents during the periodical rains. The plains of Bundelkhand are intersected by three mountain ranges, the Bindháchal, Panná, and Bander chains, the highest elevation not exceeding 2000 feet above sea-level. Beyond these ranges the country is further diversified by isolated hills rising abruptly from a common level, and presenting from their steep and nearly inaccessible scarps eligible sites for castles and strongholds, whence the mountaineers of Bundelkhand have frequently set at defiance the most powerful of the native states of India. The general slope of the country is towards the north-east, as indicated by the course of the rivers which traverse or bound the territory, and finally discharge themselves into the Jumna.

The principal rivers are the Sindh, Betwá, Ken, Baighin, Paisuní, Tons, Pahuj, Dhasán, Bermá, Urmal, and Chandrawál. The Sindh, rising near Sironj in Málwa, marks the frontier line of Bundelkhand on the side of Gwalior. Parallel to this river, but more to the eastward, is the course of the Betwá. Still further to the east flows the Ken, followed in succession by the Baighin, Paisuní, and Tons. The Jumna and the Ken are the only two navigable rivers. Notwithstanding the large number of streams, the depression of their channels and height of their banks render them for the most part unsuitable for the purposes of irrigation,—which is conducted by means of *jhils* and tanks. These artificial lakes are usually formed by throwing embankments across the lower extremities of valleys, and thus arresting and accumulating the waters flowing through them. Some of the tanks are of great capacity; the Barwá Ságar, for instance, is 2½ miles in diameter. Diamonds are found, particularly near the town of Panná, in a range of hills called by the natives Band-Ahil.

The mines of Mahárájpur, Rájpur, Kimerá, and Gadásiá contain the finest diamonds; one dug from the last is reputed to be the largest in the world. It was kept in the fort of Kalinjas among the treasures of Rájá Himmat Bahádur. In the reign of the Emperor Akbar the mines of Panná produced diamonds to the amount of £100,000 annually, and were a considerable source of revenue, but for many years they have not been so profitable.

The tree vegetation consists rather of jungle or copse than forest, abounding in game which is preserved by the native chiefs. There are also within these coverts several varieties of wild animals, such as the tiger, leopard, hyena, wild boar, *nilgái*, and jackal.

British Bundelkhand contains a population of 2,161,495 souls. The total population of Bundelkhand, British and native, has been estimated at 2,260,714. The people represent various races. The Bundelás,—the race who gave the name to the country,—still maintain their dignity as chieftains, by disdaining to cultivate the soil, although by no means conspicuous for lofty sentiments of honour or morality. An Indian proverb avers that "one native of Bundelkhand commits as much fraud as a hundred Dandis" (weighers of grain, and notorious rogues). About Datiyá and Jhánsí the inhabitants are a stout and handsome race of men, well off and contented.

The prevailing religion in Bundelkhand is Hinduism.

The principal crops are wheat, *joár*, cotton, indigo, sugar-cane, a red dye called *ách*, various kinds of millets and pulses, and *mahuá* (*Bassia latifolia*). Carpets are manufactured at Jhánsí, and paper at Kalpi. Bamboo and *Acacia catechu* from the jungles form important articles of trade. Principal routes—(1), from Allahábád to Nasírábád through Bándá; (2), from Fathipur to Ságar through Bándá; (3), from Cawnpur to Jabalpur; (4), from Cawnpur to Guná through Kálpí and Jhánsí; (5), from Bándá to Gwalior; and (6) from Agra to Ságar. The Jabalpur line of the East Indian Railway passes through the native states of Bundelkhand. Principal towns,—Kálpí, Bándá, Jhánsí. Datiyá, Urchá, Jalaun, Chhatrapur, Mahobá, and Tehárí. The climate of Bundelkhand is sultry and unhealthy.

HISTORY.—Chandra Varmá, chief of the Chandel Rájputs, appears to have established the earliest paramount power in Bundelkhand towards the close of the 9th century A.D. Under his dynasty the country attained its greatest splendour in the early part of the 11th century, when its Rájá, whose dominions extended from the Jumna to the Nerbudda, marched at the head of 36,000 horse and 45,000 foot, with 640 elephants, to oppose the invasion of Mahmúd of Ghazní. In 1183 the Chandel dynasty was overthrown by Pirthwi Ráj, the ruler of Ajmir and Delhi, after which the country remained in ruinous anarchy until the close of the 14th century, when the Bundelás, a spurious offshoot of the Garhwá tribe of Rájputs, established themselves on the right bank of the Jumna. One of these took possession of Urchá by treacherously poisoning its chief. His successor succeeded in further aggrandizing the Bundelá state, but he is represented to have been a notorious plunderer, and his character is further stained by the assassination of the celebrated Abulfazl, the prime minister and historian of Akbar. Jajhar Sinh, the third Bundelá chief, unsuccessfully revolted against the court of Delhi, and his country became incorporated for a short time with the empire. The struggles of the Bundelás for independence resulted in the withdrawal of the royal troops, and the admission of several petty states as feudatories of the empire on condition of military service. The Bundelás, under Champat Rái and his son Chhatra Sál, offered a successful resistance to the proselytizing efforts of Aurungzebe. On the occasion of a Mahometan invasion in 1732, Chhatra Sál asked and obtained the assistance of the Marhattá Peshwá, whom he adopted as his son, giving him a third of his dominions. The Marhattás gradually extended their influence over Bundelkhand, and in 1792 the Peshwá was acknowledged as the lord paramount of the country. The Marhattá power was, however, on the decline; the flight of the Peshwá from his capital to Bassein before the British arms changed the aspect of affairs, and by the treaty concluded between the Peshwá and the British Government, the districts of Bándá and Hamírpur were transferred to the latter. Two chiefs then held the ceded districts, Himmat Bahádur, the leader of the Sanyásis, who promoted the views of the British, and Shamsher, who made common cause with the Marhattás. In September 1803, the united forces of the English and Himmat Bahádur compelled Shamsher to retreat with his army. In 1809 Ajaigarh was besieged by a British force, and again three years later Kalinjár was besieged and taken after a heavy loss. In 1817, by the treaty of Poonah the British Government acquired from the Peshwá all his rights, interests, and pretensions, feudal, territorial, or pecuniary, in Bundelkhand. In carrying out the provisions of the treaty, an assurance was given by the British Government that the rights of those interested in the transfer should be scrupulously respected, and the host of petty native principalities in the province is the best proof of the sincerity and good faith with which this clause has been carried out. During the mutiny of 1857, however, many of the chiefs rose against us, especially the Rání of Jhánsí.

BUNDI, a Rájput state of India, under the political superintendence of the Government of India through its agent in Rájputáná, situated between 24° 58′ and 25° 55′ N. lat., and 75° 23′ and 76° 36′ E. long. It is bounded on the N. by the native states of Jaipur and Tonk; on the E. by the state of Kotal; on the S. by Sindhiá's territories; and on the W. by the state of Udaipur. Many parts of the state are wild and hilly, inhabited by a large Míná population, a race of robbers. Two rivers, the Chambiá and the Níj, water the state; the former is navigable by country boats. Area, 2291 square miles; population in 1871–72, 224,000, or 97 to the square mile. The chieftain and the greater part of his followers are Rájputs. Principal crops—Indian corn, *joár*, wheat, pulses, and oil-seeds. Iron is found. The chief's annual income amounts to £50,000, derived from land-tax levied both in kind and money, and from customs. Thefts and petty robberies are still of frequent occurrence. Our political relations with Bundí commenced in 1804 during the Marhattá war, and in 1818 its chief accepted our protection. The present ruler has managed the state for the last fifty years, and done much to improve the condition of the people. Bundí pays an annual tribute of £4000 to the British Government.

BUNKER HILL, a small elevation, 110 feet high, in the town of Charlestown, 1 mile N. of Boston, in Massachusetts. One of the most celebrated battles in the war of American independence was fought here on the 17th of June 1775. The British remained masters of the field after a long and bloody contest. A commemorative obelisk, 221 feet high, has been erected in the centre of the grounds included within the redoubt on Breed's Hill. See BOSTON, vol. iv. p. 72.

BUNSEN, CHRISTIAN CHARLES JOSIAS, BARON VON (1791–1860), was born 25th August 1791, at Corbach, an old town in Waldeck, one of the the smallest of German principalities. He was of honourable but humble origin. His father, to eke out the scanty subsistence provided by his few acres of land, had entered a regiment "granted" to Holland by the prince. Without promotion or encouragement, he attended conscientiously to the drudgery of his post during twenty-nine long years, to return at last, in 1789, a widower, with broken health and a miserable pension. Brighter days were in store for him through the affections of his second wife and the birth of Christian. It is on record, how joyous were the evenings in that old-fashioned Corbach home, when, after reading a chapter from the family Bible, and devoutly praying with his household, the kindly old man loved to prune, by pithy remarks and snatches of proverbial lore, the redundant enthusiasm and all-embracing fervour of his son. To the latter, success and a host of fond admirers seem from the first never to have been wanting. Nor did humility of demeanour, exquisite sympathy with all men, and an almost unexampled power of work ever fail him. The Corbach grammar school was brilliantly passed, and after it a first year of university studies, at Marburg, devoted to divinity. But Göttingen in those days attracted all superior minds, and the youth of eighteen found himself on his way thither with the last savings from his father's purse, intent upon appeasing his desire for those wider regions of philological and historical learning in which he knew his strength must lie. Again all avenues of outward success opened to the unpretending student; although so young he was entrusted with lessons at the Latin school, and soon after with the office of private tutor to W. C. Astor, only son of the well-known merchant king of New York.[1] Bunsen soon became the acknowledged though unobtrusive centre of a chosen band of students, few only of whom have failed to attain that reputation to which their abilities seemed to call them,

[1] Mr W. C. Astor, "the landlord of New York," as he has been called, died in November 1875.

or that degree of public usefulness to which in an hour of genuine enthusiasm they one and all vowed to aspire. "Right royal in all his ways," as a poet has fitly described him, he sympathized with the favourite pursuits of each, wrestled with all, made them to love each other, and held high among them the ideals of youth and of science. It was quite a day of rejoicing in Göttingen when Bunsen had won the university prize essay of the year 1812 by a treatise on the *Athenian Law of Inheritance*, and again a few months later when the university of Jena granted him, unsolicited, the honorary degree of doctor of philosophy.

The time had now come for Mr Astor to travel. Bunsen had seen little of the world before then. Only one journey had he made, but that one was to Weimar, and in company with Arthur Schopenhauer, one of his Göttingen acquaintances, a man of genius, whose fate it has been to live unknown and to become after death not famous only, but the founder of a numerous and turbulent school of metaphysicians. Bunsen was introduced to Goethe, and bore away the impress of the society that assembled around the great poet. In 1813, a journey was undertaken to South Germany, during which Mr Astor was well pleased to see his friend revelling in the company of choice spirits at each centre of intellect, and shared in his exultation over the crushing blow that had fallen upon Napoleon at Leipsic. Some months later they separated at Göttingen, Astor to return to New York, with an understanding that they would meet for further travel two years later, and Bunsen to resume his studies which had lost nothing of their vast range. It seemed to Bunsen a purpose not exceeding the limits of a man's life to comprehend the history of all Teutonic races in religion, laws, language, and literature. That was the heroic age of comparative philology; and thus we see Bunsen, who had read Hebrew when a boy, plunging into Arabic at Munich, Persian at Leyden, and Norse at Copenhagen, as opportunities offered for each.

At the close of 1815 Bunsen found his way to Berlin, to lay before Niebuhr the historian what was then already a many years' plan of learned inquiry. This step led to important consequences in the life of Bunsen. Niebuhr not only approved of the Titanic scheme, and hoped that Prussia, in which all the hope of Germans then began to be centred, would in time find money for assisting it, but so powerful an impression did he receive on that occasion, that when they met again two years later, Niebuhr, having meanwhile become Prussian envoy to the Papal court, exerted all his influence to draw Bunsen into official life. Of the two intervening years it will suffice to relate that they had been spent by Bunsen in assiduous labour among the libraries and collections of Paris and Florence, whither the hope of meeting his former pupil, Mr Astor, had led him; and that he contracted during his stay in the capital of France a love for the peculiar graces of French genius which never left him through life.

Fascinated by the condescending friendship of Niebuhr, by the glories of Rome, and also by the charms of English society, Bunsen continued his stay in that city. In July 1817 he married Miss Waddington, eldest daughter and co-heiress of Mr B. Waddington of Llanover, Monmouthshire. Even then his purposes in life remained purely scientific. Little did he dream that the Eternal City was to become his home for twenty-one years, or that one of the most difficult problems of European diplomacy would there be entrusted to his hands.

When Niebuhr obtained the consent of his Government for the appointment of Bunsen as secretary of the Roman embassy, negotiations were being actively carried on between Berlin and Rome for a new establishment of the Papal Church in the Prussian dominions. This had become necessary, since 1815, by the addition of several millions of Catholics to the population of that mainly Protestant country, of which they now formed no less than two-fifths. An agreement was the fruit of these labours, by which the king of Prussia allowed the publication within his dominions of a Papal bull (called *De salute animarum*), circumscribing the Catholic dioceses, and determining the position of the Romanist hierarchy. During this period of initiation into the mysteries of Papal statecraft, Bunsen had occasion to learn that the Vatican began, under the fostering care of the Jesuit order, to revive from the inanition into which the French Revolution and its effects had thrown it. So universal and so strong was the wave of reaction in those days throughout Europe, that Protestant and Catholic rulers agreed in the conviction that of all conservatism the apex and supreme exponent must be the Pope, as representing "the most ancient succession of sovereigns," as "upholder of things as they are." Considering themselves the Pope's born allies, they closed their eyes to that stealthy encroachment of absolute Romish power into the dioceses within their territory with which the present generation is becoming acquainted in America as well as in Europe. Bunsen was among those who first discerned the coming danger. To direct official attention towards it, to ward it off by fairness and impartiality towards his Catholic fellow-subjects, to preserve religious peace in his country, thenceforward became the main object of his official labours.

At first his success was great. In Berlin the king and his minister, and at Rome each successive Pope and his cardinal secretary, bestowed upon him every mark of confidence and even of affection. King Frederick William III. had made his acquaintance as early as 1822 during a brief stay at Rome, and had taken unwonted pleasure not only in his conversation generally, but even in the outspoken but elegant frankness with which Bunsen defended his views when at variance with one or two of his sovereign's favourite theories. He evinced his appreciation of the youthful diplomatist by desiring him to undertake the legation after Niebuhr's retirement from his office.

In the Papal Government, also, Bunsen's honest endeavours to preserve a good understanding were readily acknowledged, and formed the basis for one of the rarest life friendships, and yet a most real one, with Monsignor Capaccini, the confidential adviser of successive Popes in foreign affairs, who never swerved from his principle of both receiving and meeting every communication of the Prussian envoy with equal trust and truthfulness.

A few words will explain the causes which eventually led to a failure of Bunsen's pacific efforts. Marriages between Romanists and Protestants (or so-called mixed marriages) had formerly been of rare occurrence in Prussia. Before the iron will of Frederick the Great, the naive demands of the hierarchy of Silesia—the chief of which is a promise on oath that all children shall be brought up as Catholics—had dwindled into a passive attitude on their part. After the accession of Rhineland and Westphalia to the Prussian monarchy had added to the frequency of such marriages, it was truly fortunate that a prelate of moderate views in matters ecclesiastical and a good patriot—Count Spiegel—held the archiepiscopal see of Cologne (1825). With him, who forbade processions of his own accord as leading to immorality, and who favoured a more enlightened education of candidates for holy orders, an arrangement which would leave the consciences of spouses and priests unviolated was practicable. It was easily obtained by Bunsen's personal negotiation with the archbishop. The other Prussian bishops also consented; but such was the slothfulness of the absolute king's Government, that the death of that wise archbishop (1835) occurred before its ratification, and such their blindness to reality that they

offered to promote a narrow-minded ascetic, Baron Droste, to the vacant post. "Is your king mad?" bluntly exclaimed the cardinal-secretary, whilst hastening to accept, on the part of the Vatican, the proffered tool of Papal aggression! Before two years had passed the religious strife was in a blaze everywhere,—Jesuit advisers more eagerly listened to at Rome, Prussian bishops all but unanimous in their opposition against moderate counsels, and (so the Government was informed) the leadership of these machinations against the internal peace of Prussia entrusted to members of that uniformly Ultramontane body, the Belgian bishops. In this extremity Bunsen was again summoned to Berlin from his post. It is difficult at this distance of time to discern how far the advice he may have given was founded upon too sanguine a view both of the power of an absolute king, unaided by an emancipated public opinion, a free press, or a parliament, and of the intensity of the agitation raging in Catholic districts. But this much is known that, when the seizure of the chief offender in his archiepiscopal palace at Cologne was resolved upon, Bunsen understood that the archbishop would forthwith be placed before the ordinary judges of the country for disobedience to its laws. This was never done, and the seizure was so mismanaged that the incriminating documents are said to have been destroyed before the judicial authorities had set foot in the palace. Thus a complete failure was the result of this very unsafe step. The Government thought it easier to leave Bunsen unsupported when, after his return to Rome, he courageously attempted to convince the Vatican of the archbishop's guilt, and, in the hope of burying the matter in oblivion, they accepted Bunsen's offer of resignation, in April 1838. It may not be irrelevant to mention here that the king's successor, Frederick William IV., on his elevation to the throne in 1840, released Baron Droste from prison. This romantic king established his policy towards the Vatican on the principle of granting liberty of action to the Papal power,—a liberty so well employed both before and since the revolution of 1848, that at this moment (1876) all the energies of a powerful chancellor and a united Germany are taxed to the utmost to find a basis for harmonious coexistence between modern states and the hierarchy of Rome.

When Bunsen left the Eternal City a politically disappointed man, he was able, nevertheless, to look back upon a term of years filled with everything that could adorn life—intense domestic contentment, intimacy with distinguished men of every nation who had sojourned in Rome during his twenty-one years' residence there, success in establishing institutions which, like the Archæological Institute, the German Hospital, and the Protestant chapel, have outlived his stay, experience in public affairs, and a deepening of his religious convictions. Religion had become the centre of his most tender emotions, of his intellectual activity, of his practical aspirations. To restore to the Bible that place in the households of his country which it had possessed in the first generations after the Reformation, to revive the knowledge and the love of the German reformers' hymns, to give his people such a Book of Common Prayer, resting upon the liturgies of all Christian ages, as would help congregations in "presenting themselves a living sacrifice," to rekindle the fervour of other days for works of self-devotion and charity, to work out a Christian philosophy of history,—such were the purposes to which he devoted his happiest and best hours in each succeeding year. Whilst he was at Rome a book of ancient hymns and a liturgy were printed.

Bunsen always looked back in later years upon his Roman time as men are apt to remember their college days. Right joyous had been his intercourse with artists such as Thorwaldsen, Rauch, Wolff, Cornelius, Schnorr, Overbeck, Schinkel, Felix Mendelssohn. He had become one of the best-informed men among art-collections, and was so attracted by the charms of Roman topography as to surrender to the temptation of contributing volumes to the German *Description of Rome*.

Few strangers have ever lived on terms of greater intimacy with Italians, or possessed a more entire command of their language than Bunsen. He was a believer in their national revival and political future at a time when Italy was "a geographical expression" only and when her art treasures and her blue sky were her only acknowledged qualities. Among Americans Mr Ticknor; among Russians Italinsky, Joukovsky, and Al. Tourgenieff; among Frenchmen the Duc de Blacas, Comte de St Aulaire, Chateaubriand, Champollion, Ampère, and others became his friends. But his most cherished intercourse was with English visitors and residents,[1] to which he owed an acquaintance with British life such as has rarely been possessed by any foreigner who never had set foot in this country.

Towards England, then, did he turn his face in 1838 to enjoy the leisure occasioned by his removal from the Capitol, and in England, except when he held a brief diplomatic appointment as Prussian ambassador to Switzerland from 1839 to 1841, the remainder of his official life was spent.

Between the Crown Prince of Prussia and Bunsen a very close intimacy had sprung up ever since they met at Berlin in 1828. They were attracted to each other by similarity of literary tastes, of poetic temperament, and of religious aspiration. In their enthusiasm for each other, the prince as well as the public servant fondly hoped, year after year, that diversity of character and of self-grown conviction, however marked, would tend rather to compensate defects than to disturb harmonious action. Their correspondence lately published (in part) by Ranke, the historian, shows the truthfulness and the durability of this remarkable friendship, and helps to explain why its results were not commensurate to the moral worth and intellectual capacity of the men who were united by it.

The new king had no sooner ascended the throne under the name of Frederick William IV. than he contemplated the erection of an Anglo-Prussian bishopric at Jerusalem, intended to represent European Protestantism as a united power, and to give a rallying point to Protestant missions in Syria and Palestine. The time seemed propitious for this fantastic scheme. The four allied powers, under the leadership of Great Britain, had reinstated the sultan in the possession of Syria. The Turkish Government would therefore readily grant a similar representation to Protestant churches to that possessed by Orthodox Greeks and Roman Catholics. King Frederick William summoned Bunsen to his capital, and instructed him to negotiate in London the establishment of such a bishopric on Mount Zion. In an incredibly short time (June to November 1841) Bunsen succeeded in bringing it about, with the English Government's courteous assent, and the energetic furtherance of the archbishop of Canterbury and the bishop of London, Prussia paying in a capital which secured one-half of its endowment, whilst the other half was to be raised in England. Much suspicion was felt and opposition raised against any association of the Church of England with German Protestantism, in both countries alike, though from

[1] One of these, and a very valued correspondent of Bunsen, was Lord Clifford, well known as a devout Roman Catholic. He had made the struggle between Berlin and the Vatican the subject of earnest study, and was enabled by his high social position to obtain from documents a more dispassionate view of it than, perhaps, any contemporary witness of the events. His testimony, therefore, expressed in a letter to Bunsen of 31st March 1838, may claim a place in this sketch. Lord Clifford writes,—"Your public career here has been of benefit to the peace of Europe."

opposite motives. To Bunsen this "special mission" brought in a rich harvest of friendly feeling among the leaders of both parliamentary parties, so that when Queen Victoria selected his name out of three proposed by the chivalrous courtesy of the Prussian king for the post of Prussian ambassador, he found himself well received by all classes of English society. The king's visit to England in February 1842, as sponsor to the Prince of Wales, helped to prove the earnest desire of Prussia to seek the friendship of Great Britain. An event, however, which directed the eyes of the British public even more to Bunsen than royal favour was the publication of Arthur Stanley's *Life of Dr Arnold*, in whose private letters an admiration amounting almost to enthusiasm for his German friend was expressed with a fervour unusual to Arnold's stately reserve. Although not palatable to the growing ritualistic school, and not always considered a safe theologian by the partizan leaders of the Low Church, Bunsen retained to the last the affection of the British nation, among whom he spent thirteen eventful years.

In the year 1844 his advice was asked by the king on the constitutional changes,—from absolutism to a representative government,—upon which Prussia, although in a first-rate financial military and administrative condition, found herself irresistibly constrained to enter. His advice, though studiously conservative, was considered of too sweeping a nature, and the king contented himself in 1847 with convoking an assembly composed of all members of the eight provincial diets of the monarchy, and clothed with scarcely any constitutional powers.

On the question of church organization, also, the king and his friend were fated to disagree more strongly than they had expected. Bunsen's views had developed into a system essentially Presbyterian, though with an Episcopal headship. He held up the constitution of the Episcopal Church of America as, perhaps, the best type to follow, because it contained personal rule organically allied to the free power of the laity. He recommended these ideas to his countrymen as well as to his sovereign in a book entitled *The Church of the Future*, which has not been without influence in the church constitution now (1876) about to become law in Prussia.

The king's expectations of a quiet time for maturing his work of reconstruction in church and state were rudely broken in upon by the French Revolution of February 1848. Bunsen's warning voice had been raised in vain; the discontent of the educated classes helped to weaken the distracted councils of Frederick William IV., and, though a constitution was eventually promulgated, Prussian politics succumbed under the tutelage of the Austrian premier, Prince Schwarzenberg, in 1849 Bunsen's diplomatic labours were mainly directed to settle, as German commissioner, the dispute with Denmark about the duchies of Holstein and Schleswig, Great Britain having offered her mediation. In these duchies a strong agitation of several years' standing had roused the German population, which occupies the whole of the former and part of the latter, to oppose the centralizing tendencies of the Danish Government. During the troubles of March 1848 they had taken up arms against Denmark and found assistance in Germany, then for the first time aspiring again to the position of a national power. This disturbance of the public peace of Europe was, however, regarded with so much disfavour by all powers, and secretly also by the sovereigns of Prussia and Austria, that the Danes obtained, in 1852, a European protocol, which reversed the political autonomy of the two duchies, and settled the crown of Denmark, after the death of the king and his son, upon Prince Christian of Glücksburg. It was the fate of Bunsen to be obliged to add his signature to this protocol, although it contained an abrogation of those "constitutional rights of Schleswig and Holstein," upon which he had dilated in a *Letter to Viscount Palmerston*, printed in April 1848.

The unity of Germany was another of those wishes in which Bunsen and his royal patron had been one ever since the beginning of their acquaintance, and yet found themselves widely apart when the question came to be practically tested. The king sincerely aimed at the resuscitation of the venerable German empire, fancying that the leadership within the federation of sovereigns might be divided between Austria and Prussia, yet so as to leave a kind of ceremonial primacy to the former. Enlightened Germans, on the contrary, had then already arrived at the conviction that the leadership must be in Prussian hands. Austria, hampered as she is by the numerical preponderance of non-German populations, and the divergence of her interests from those of Germany, should, they thought, take her place within a wider federation. Gradually and almost imperceptibly did this truth work its way through time-honoured tradition. Bunsen was one of its most eloquent apostles, in his official correspondence as well as in pamphlets published in 1848. Several times he was sanguine enough to believe such a policy to be permanently grasped in Berlin, but the king's vacillating temper and his adherence to tradition refused to be wrought upon beyond the approval of half-measures. Thus the opportunity was lost, the potentiality of the Prussian military power neglected, and a gnawing disappointment left in the minds of the best patriots throughout Germany.

With small hopes, and with no other wish but to serve as long as possible a sovereign whose friendship and confidence had outlived their former agreement on matters of religion and policy, Bunsen continued in the thankless task of representing Prussia after the downfall of those proud hopes that had pictured forth a revival of the German nationality under Prussian leadership. His main object, pursued under every difficulty, and seized with energy on every favourable opportunity, was to dissociate the policy of Berlin from that of St Petersburg and Vienna, and to draw closer whatever bonds of common sentiment or interest existed between the English and German communities. He was not tardy, therefore, in advising his royal master in an anti-Russian sense when the Crimean war began. As had so often been the case, the king's understanding went along with much that Bunsen wrote, and hopes were entertained that a Prussian participation in the war, containing the threat of an invasion of the north-western frontier of Russia, would force that country into compliance with the demands of the Western powers. But traditional policy again prevailed, mixed with the king's unconquerable aversion to Napoleon III., and his growing mistrust of Lord Palmerston's political principles. The alliance of the Western powers was declined, Prussia preserved towards her Eastern neighbour what is technically called a "benevolent neutrality," and the king accepted Bunsen's proffered resignation of his post as minister in London in April 1854.

The remaining years of Bunsen's life were spent in almost unbroken literary labours, first at a villa on the banks of the Neckar, near Heidelberg, and at the last in Bonn. In the politics of the day his interest was as keen as ever, and readily did he give his advice when advice was asked, as happened frequently on the part of the prince and princess of Prussia then residing at Coblentz, who have since risen to the exalted position of emperor and empress of Germany. But declining health determined him not to enter the Prussian Lower House, in which a seat was offered him by the liberal majority in the city of Magdeburg. His *Signs of the Times*, however, an elaborate pamphlet, published in 1856, acted like a first trumpet-call

against the aggressive demeanour of the reactionary clique, who were utilizing, in the interests of despotism and obscurantism, the horror of revolutionary outbreaks then felt by the quiet middle classes of Germany. Its publication prepared the way, more perhaps than any other event, for that rise of liberal opinion in Prussia which showed its power in the next reign.

Twice only was Bunsen tempted away from his Heidelberg retreat to show himself at Berlin,—once, at the king's desire and as his guest, in September 1857, to attend the meeting of the Evangelical Alliance, in the main objects of which he sympathized as warmly as King Frederick William IV. On that occasion, and after much confidential intercourse, the two friends parted never to meet again on this side of the grave. One of the last papers signed by the king before his mind gave way in October of that year was that which raised Bunsen to the rank of baron, and conferred upon him a life peerage. In 1858 the Regent (now Emperor) William having addressed a special request to Baron Bunsen not to fail him at the opening of his first parliament, he took his seat in the Upper House, and supported actively during a brief autumn session, but without ever making a speech, the regent's new cabinet, of which several of Bunsen's political and personal friends were members.

Literary work was, however, the centre of his life throughout that time. Two discoveries of ancient MSS. which occurred during his stay in London, containing, the one a shorter text of the *Epistles of St Ignatius*, and the other an unknown work *On all the Heresies*, by Bishop Hippolytus, had already given him an opportunity for enlarging upon the history of the first centuries of the Christian Church. He now concentrated all his efforts upon producing a Bible translation with commentaries that would open the sacred volumes afresh to the understanding and the hearts of a generation gradually estranged from them. Whilst this "*Bible-work*," was in preparation, and to pave the way for its reception, he printed a book considered by many to contain his most matured thoughts, under the title of *God in History*. The progress of mankind, he contends, marches parallel to the conception of God formed within each nation by the highest exponents of its thought. At the same time he carried through the press, ably assisted by Mr Birch the Egyptologist, the concluding volumes of his work (published in English as well as in German) *Egypt's Place in Universal History*—containing a reconstruction of Egyptian chronology, together with an attempt to determine the relation in which the language and the religion of that country stands to the development of each among the more ancient non-Aryan and Aryan races, between which its curious civilization seems to have formed a kind of connecting link. Those who desire to know Bunsen's ideas on this subject may find them most fully developed in two volumes published in London before he quitted England—*Outlines of the Philosophy of Universal History as applied to Language and Religion*. It will be seen even from this brief outline that his "first love" had never lost its hold upon him, and that the desire "to trace the firm path of God through the stream of ages" continued his purpose for life.[1]

But asthma and all other concomitants of a malady that had announced itself for years now began to disturb, not the mental alacrity or the spirits of Bunsen himself, but the hopes of his family and those among his friends who had imagined that he would be allowed to complete the works undertaken. Ordered to spend his winters in a more genial climate, he repaired to Cannes in 1858 and 1859, not without a lengthened visit to Paris, where he revelled, as in younger days, in the contact with men of learning. In May 1860 he purchased a house in Bonn, hoping against hope, pushing forward the publication of his *Bibel-Werk*, and even preparing lectures for students upon those subjects which he had most at heart. But the hand of death was upon him. He thanked God daily for teaching him how to support pain at the close of a life so eminently exempt from bodily suffering. And whenever, in the closing weeks of his existence on earth, a relaxation of asthma ensued, fervent prayer flowed from his lips, powerful attestation of his religious belief, loving exhortation to those from whom he was soon to be removed. Baron Bunsen died on November 28, 1860, and lies buried in the churchyard of Bonn, not far from the grave of his early friend and benefactor Niebuhr.

"Let us walk in the light of the Lord" (Isa. ii. 5) is the text which Baroness Bunsen placed on his tomb. One of his last requests having been that she would write down recollections of their common life, she published his *Memoirs* in 1868, which contain much of his private correspondence. The German translation of these *Memoirs* has added extracts from unpublished documents, throwing a new light upon the political events in which he played a part. Baron Humboldt's letters to Bunsen were printed in 1869, and Ranke published in 1873 a large portion of the correspondence that passed between King Frederick William IV. and Bunsen. (G. V. B.)

BUNTING, a word of uncertain origin, properly the common English name of the bird called by Linnæus *Emberiza miliaria*, but now used in a general sense for all members of the family *Emberizidæ*, which are closely allied to the Finches (*Fringillidæ*), though, in Professor Parker's opinion, to be easily distinguished therefrom—the *Emberizidæ* possessing what none of the *Fringillidæ* do, an additional pair of palatal bones, "palato-maxillaries." It will probably follow from this diagnosis that some forms of birds, particularly those of the New World, which have hitherto been commonly assigned to the latter, really belong to the former, and among them the genera *Cardinalis* and *Phrygilus*. The additional palatal bones just named are also found in several other peculiarly American families, namely, *Tanagridæ*, *Icteridæ*, and *Mniotiltidæ*—whence it may be perhaps inferred that the *Emberizidæ* are of Transatlantic origin. The Buntings generally may be also outwardly distinguished from the Finches by their angular gape, the posterior portion of which is greatly deflected; and most of the Old-World forms, together with some of those of the New World, have a bony knob on the palate—a swollen out growth of the dentary edges of the bill. Correlated with this peculiarity the maxilla usually has the tomia sinuated, and is generally concave, and smaller and narrower than the mandible, which is also concave to receive the palatal knob. In most other respects the Buntings greatly resemble the Finches, but their eggs are generally distinguishable by the irregular hair-like markings on the shell. In the British Islands by far the commonest species of Bunting is the Yellow Hammer (*E. citrinella*), but the true Bunting (or Corn-Bunting, or Bunting-Lark, as it is called in some districts) is a very well-known bird, while the Reed-Bunting (*E. schœniclus*) frequents marshy soils almost to the exclusion of the two former. In certain localities in the south of England the Cirl-Bunting (*E. cirlus*) is also a resident; and in winter vast flocks of the Snow-Bunting (*Plectrophanes nivalis*), at once recognizable by its pointed wings and elongated hind-claws, resort to our shores and open grounds. This last is believed to breed sparingly on the highest mountains of Scotland, but the majority of the examples which visit us come from northern regions, for it is a species which in summer

[1] It may be mentioned that Bunsen contributed the article LUTHER, one of the finest biographies of the great Reformer, to the eighth edition of the present work, 1857.

inhabits the whole circumpolar area. The Ortolan (*E. hortulana*), so highly prized for its delicate flavour, occasionally appears in England, but this island seems to lie outside its proper range. On the continent of Europe, in Africa, and throughout Asia, many other species are found, while in America the number belonging to the family cannot at present be computed. As already stated, the beautiful and melodious Cardinal (*Cardinalis virginianus*), commonly called the Virginian Nightingale, must be included in this family, as also the Bobolink (*Dolichonyx oryzivorus*), a bird for sapidity perhaps surpassing the far-famed Ortolan, and intimately connecting the *Emberizidæ* with the *Icteridæ*. Whether any species of the family inhabit the Australian Region is as yet doubtful, but it would seem possible that several genera of Australian birds hitherto classed with the *Fringillidæ* may have to be assigned to the *Emberizidæ*. (A. N.)

BUNTING, JABEZ, D.D., a distinguished Wesleyan minister, who exerted an influence in his denomination second only to that of John Wesley himself, was born at Manchester 13th May 1779, and died on the 16th June 1858. He was educated at the grammar school of his native town. At the age of nineteen he began to preach, and a year later (1799) he became a member of the Conference. He continued in the active discharge of his ministerial duties for upwards of fifty-seven years—his successive spheres of labour being Manchester, Liverpool, and London. In 1834 he was appointed president of the newly-founded Wesleyan theological college, and in this position, which he held till his death, he succeeded in materially raising the standard of education among Wesleyan ministers. He was four times chosen to be president of the Conference, was repeatedly secretary of the "Legal Hundred," and for eighteen years was secretary to the Wesleyan Missionary Society. In these and other offices he found ample scope for that great natural sagacity and power of administration which did so much for the consolidation and extension of the Wesleyan denomination. Dr Bunting was a popular preacher, and an effective platform speaker. Two volumes of his sermons were published posthumously in 1862. The first volume of a memoir, by his son, appeared in 1860.

BUNYAN, JOHN (1628–1688), the most popular religious writer in the English language, was born at Elstow, about a mile from Bedford, in the year 1628. He may be said to have been born a tinker. The tinkers then formed a hereditary caste, which was held in no high estimation. They were generally vagrants and pilferers, and were often confounded with the gipsies, whom in truth they nearly resembled. Bunyan's father was more respectable than most of the tribe. He had a fixed residence, and was able to send his son to a village school where reading and writing were taught.

The years of John's boyhood were those during which the Puritan spirit was in the highest vigour all over England; and nowhere had that spirit more influence than in Bedfordshire. It is not wonderful, therefore, that a lad to whom nature had given a powerful imagination and sensibility which amounted to a disease, should have been early haunted by religious terrors. Before he was ten, his sports were interrupted by fits of remorse and despair; and his sleep was disturbed by dreams of fiends trying to fly away with him. As he grew older, his mental conflicts became still more violent. The strong language in which he described them has strangely misled all his biographers except Mr Southey. It has long been an ordinary practice with pious writers to cite Bunyan as an instance of the supernatural power of divine grace to rescue the human soul from the lowest depths of wickedness. He is called in one book the most notorious of profligates; in another, the brand plucked from the burning. He is designated in Mr Ivimey's *History of the Baptists* as the depraved Bunyan, the wicked tinker of Elstow. Mr Ryland, a man once of great note among the dissenters, breaks out into the following rhapsody:—"No man of common sense and common integrity can deny that Bunyan was a practical atheist, a worthless contemptible infidel, a vile rebel to God and goodness, a common profligate, a soul-despising, a soul-murdering, a soul-damning, thoughtless wretch as could exist on the face of the earth. Now be astonished, O heavens, to eternity! and wonder, O earth and hell! while time endures. Behold this very man become a miracle of mercy, a mirror of wisdom, goodness, holiness, truth, and love." But whoever takes the trouble to examine the evidence will find that the good men who wrote this had been deceived by a phraseology which, as they had been hearing it and using it all their lives, they ought to have understood better. There cannot be a greater mistake than to infer from the strong expressions in which a devout man bemoans his exceeding sinfulness, that he has led a worse life than his neighbours. Many excellent persons, whose moral character from boyhood to old age has been free from any stain discernible to their fellow-creatures, have, in their autobiographies and diaries, applied to themselves, and doubtless with sincerity, epithets as severe as could be applied to Titus Oates or Mrs Brownrigg. It is quite certain that Bunyan was, at eighteen, what, in any but the most austerely puritanical circles, would have been considered as a young man of singular gravity and innocence. Indeed, it may be remarked that he, like many other penitents who, in general terms, acknowledge themselves to have been the worst of mankind, fired up, and stood vigorously on his defence, whenever any particular charge was brought against him by others. He declares, it is true, that he had let loose the reins on the neck of his lusts, that he had delighted in all transgressions against the divine law, and that he had been the ringleader of the youth of Elstow in all manner of vice. But when those who wished him ill accused him of licentious amours, he called on God and the angels to attest his purity. No woman, he said, in heaven, earth, or hell, could charge him with having ever made any improper advances to her. Not only had he been strictly faithful to his wife; but he had, even before his marriage, been perfectly spotless. It does not appear from his own confessions, or from the railings of his enemies, that he ever was drunk in his life. One bad habit he contracted, that of using profane language; but he tells us that a single reproof cured him so effectually that he never offended again. The worst that can be laid to the charge of this poor youth, whom it has been the fashion to represent as the most desperate of reprobates, as a village Rochester, is, that he had a great liking for some diversions, quite harmless in themselves, but condemned by the rigid precisians among whom he lived, and for whose opinion he had a great respect. The four chief sins of which he was guilty were dancing, ringing the bells of the parish church, playing at tipcat, and reading the history of Sir Bevis of Southampton. A rector of the school of Laud would have held such a young man up to the whole parish as a model. But Bunyan's notions of good and evil had been learned in a very different school; and he was made miserable by the conflict between his tastes and his scruples.

When he was about seventeen, the ordinary course of his life was interrupted by an event which gave a lasting colour to his thoughts. He enlisted in the Parliamentary army, and served during the decisive campaign of 1645. All that we know of his military career is, that, at the siege of Leicester, one of his comrades, who had

taken his post, was killed by a shot from the town. Bunyan ever after considered himself as having been saved from death by the special interference of Providence. It may be observed that his imagination was strongly impressed by the glimpse which he had caught of the pomp of war. To the last he loved to draw his illustrations of sacred things from camps and fortresses, from guns, drums, trumpets, flags of truce, and regiments arrayed each under its own banner. His Greatheart, his Captain Boanerges, and his Captain Credence are evidently portraits, of which the originals were among those martial saints who fought and expounded in Fairfax's army.

In a few months Bunyan returned home, and married. His wife had some pious relations, and brought him as her only portion some pious books. And now his mind, excitable by nature, very imperfectly disciplined by education, and exposed, without any protection, to the infectious virulence of the enthusiasm which was then epidemic in England, began to be fearfully disordered. In outward things he soon became a strict Pharisee. He was constant in attendance at prayers and sermons. His favourite amusements were, one after another, relinquished, though not without many painful struggles. In the middle of a game at tipcat he paused, and stood staring wildly upwards with his stick in his hand. He had heard a voice asking him whether he would leave his sins and go to heaven, or keep his sins and go to hell; and he had seen an awful countenance frowning on him from the sky. The odious vice of bell-ringing he renounced; but he still for a time ventured to go to the church tower and look on while others pulled the ropes. But soon the thought struck him that, if he persisted in such wickedness, the steeple would fall on his head; and he fled in terror from the accursed place. To give up dancing on the village green was still harder; and some months elapsed before he had the fortitude to part with his darling sin. When this last sacrifice had been made, he was, even when tried by the maxims of that austere time, faultless. All Elstow talked of him as an eminently pious youth. But his own mind was more unquiet than ever. Having nothing more to do in the way of visible reformation, yet finding in religion no pleasures to supply the place of the juvenile amusements which he had relinquished, he began to apprehend that he lay under some special malediction; and he was tormented by a succession of fantasies which seemed likely to drive him to suicide or to Bedlam.

At one time he took it into his head that all persons of Israelite blood would be saved, and tried to make out that he partook of that blood; but his hopes were speedily destroyed by his father, who seems to have had no ambition to be regarded as a Jew.

At another time Bunyan was disturbed by a strange dilemma: "If I have not faith, I am lost; if I have faith, I can work miracles." He was tempted to cry to the puddles between Elstow and Bedford, "Be ye dry," and to stake his eternal hopes on the event.

Then he took up a notion that the day of grace for Bedford and the neighbouring villages was past; that all who were to be saved in that part of England were already converted; and that he had begun to pray and strive some months too late.

Then he was harassed by doubts whether the Turks were not in the right, and the Christians in the wrong. Then he was troubled by a maniacal impulse which prompted him to pray to the trees, to a broomstick, to the parish bull. As yet, however, he was only entering the valley of the shadow of death. Soon the darkness grew thicker. Hideous forms floated before him. Sounds of cursing and wailing were in his ears. His way ran through stench and fire, close to the mouth of the bottomless pit. He began to be haunted by a strange curiosity about the unpardonable sin, and by a morbid longing to commit it. But the most frightful of all the forms which his disease took was a propensity to utter blasphemy, and especially to renounce his share in the benefits of the redemption. Night and day, in bed, at table, at work, evil spirits, as he imagined, were repeating close to his ear the words, "Sell him, sell him." He struck at the hobgoblins; he pushed them from him; but still they were ever at his side. He cried out in answer to them, hour after hour, "Never, never; not for thousands of worlds; not for thousands." At length, worn out by this long agony, he suffered the fatal words to escape him, "Let him go if he will." Then his misery became more fearful than ever. He had done what could not be forgiven. He had forfeited his part of the great sacrifice. Like Esau, he had sold his birthright; and there was no longer any place for repentance. "None," he afterwards wrote, "knows the terrors of those days but myself." He has described his sufferings with singular energy, simplicity, and pathos. He envied the brutes; he envied the very stones on the street, and the tiles on the houses. The sun seemed to withhold its light and warmth from him. His body, though cast in a sturdy mould, and though still in the highest vigour of youth, trembled whole days together with the fear of death and judgment. He fancied that this trembling was the sign set on the worst reprobates, the sign which God had put on Cain. The unhappy man's emotion destroyed his power of digestion. He had such pains that he expected to burst asunder like Judas, whom he regarded as his prototype.

Neither the books which Bunyan read, nor the advisers whom he consulted, were likely to do much good in a case like his. His small library had received a most unseasonable addition, the account of the lamentable end of Francis Spira. One ancient man of high repute for piety, whom the sufferer consulted, gave an opinion which might well have produced fatal consequences. "I am afraid," said Bunyan, "that I have committed the sin against the Holy Ghost." "Indeed," said the old fanatic, "I am afraid that you have."

At length the clouds broke; the light became clearer and clearer; and the enthusiast who had imagined that he was branded with the mark of the first murderer, and destined to the end of the arch-traitor, enjoyed peace and a cheerful confidence in the mercy of God. Years elapsed, however, before his nerves, which had been so perilously overstrained, recovered their tone. When he had joined a Baptist society at Bedford, and was for the first time admitted to partake of the eucharist, it was with difficulty that he could refrain from imprecating destruction on his brethren while the cup was passing from hand to hand. After he had been some time a member of the congregation, he began to preach; and his sermons produced a powerful effect. He was indeed illiterate; but he spoke to illiterate men. The severe training through which he had passed had given him such an experimental knowledge of all the modes of religious melancholy as he could never have gathered from books; and his vigorous genius, animated by a fervent spirit of devotion, enabled him not only to exercise a great influence over the vulgar, but even to extort the half-contemptuous admiration of scholars. Yet it was long before he ceased to be tormented by an impulse which urged him to utter words of horrible impiety in the pulpit.

Counter-irritants are of as great use in moral as in physical diseases. It should seem that Bunyan was finally relieved from the internal sufferings which had embittered his life by sharp persecution from without. He had been five years a preacher, when the Restoration

put it in the power of the Cavalier gentlemen and clergymen all over the country to oppress the dissenters; and, of all the dissenters whose history is known to us, he was perhaps the most hardly treated. In November 1660 he was flung into Bedford jail; and there he remained, with some intervals of partial and precarious liberty, during twelve years. His persecutors tried to extort from him a promise that he would abstain from preaching; but he was convinced that he was divinely set apart and commissioned to be a teacher of righteousness, and he was fully determined to obey God rather than man. He was brought before several tribunals, laughed at, caressed, reviled, menaced, but in vain. He was facetiously told that he was quite right in thinking that he ought not to hide his gift; but that his real gift was skill in repairing old kettles. He was compared to Alexander the coppersmith. He was told that if he would give up preaching he should be instantly liberated. He was warned that if he persisted in disobeying the law he would be liable to banishment, and that if he were found in England after a certain time his neck would be stretched. His answer was, "If you let me out to-day, I will preach again tomorrow." Year after year he lay patiently in a dungeon, compared with which the worst prison now to be found in the island is a palace. His fortitude is the more extraordinary because his domestic feelings were unusually strong. Indeed, he was considered by his stern brethren as somewhat too fond and indulgent a parent. He had several small children, and among them a daughter who was blind, and whom he loved with peculiar tenderness. He could not, he said, bear even to let the wind blow on her; and now she must suffer cold and hunger; she must beg; she must be beaten; "yet," he added, "I must, I must do it." While he lay in prison, he could do nothing in the way of his old trade for the support of his family. He determined, therefore, to take up a new trade. He learned to make long-tagged thread laces; and many thousands of these articles were furnished by him to the hawkers. While his hands were thus busied he had other employments for his mind and his lips. He gave religious instruction to his fellow-captives, and formed from among them a little flock, of which he was himself the pastor. He studied indefatigably the few books which he possessed. His two chief companions were the Bible and Fox's *Book of Martyrs*. His knowledge of the Bible was such that he might have been called a living concordance; and on the margin of his copy of the *Book of Martyrs* are still legible the ill-spelt lines of doggrel in which he expressed his reverence for the brave sufferers, and his implacable enmity to the mystical Babylon.

At length he began to write, and though it was some time before he discovered where his strength lay, his writings were not unsuccessful. They were coarse, indeed, but they showed a keen mother wit, a great command of the homely mother tongue, an intimate knowledge of the English Bible, and a vast and dearly bought spiritual experience. They therefore, when the corrector of the press had improved the syntax and the spelling, were well received by the humbler class of dissenters.

Much of Bunyan's time was spent in controversy. He wrote sharply against the Quakers, whom he seems always to have held in utter abhorrence. It is, however, a remarkable fact that he adopted one of their peculiar fashions; his practice was to write, not November or December, but eleventh month and twelfth month.

He wrote against the liturgy of the Church of England. No two things, according to him, had less affinity than the form of prayer and the spirit of prayer. Those, he said with much point, who have most of the spirit of prayer are all to be found in jail; and those who have most zeal for the form of prayer are all to be found at the alehouse. The doctrinal Articles, on the other hand, he warmly praised, and defended against some Arminian clergymen who had signed them. The most acrimonious of all his works is his answer to Edward Fowler, afterwards bishop of Gloucester, an excellent man, but not free from the taint of Pelagianism.

Bunyan had also a dispute with some of the chiefs of the sect to which he belonged. He doubtless held with perfect sincerity the distinguishing tenet of that sect, but he did not consider that tenet as one of high importance, and willingly joined in communion with pious Presbyterians and Independents. The sterner Baptists, therefore, loudly pronounced him a false brother. A controversy arose which long survived the original combatants. In our own time the cause which Bunyan had defended with rude logic and rhetoric against Kiffin and Danvers was pleaded by Robert Hall with an ingenuity and eloquence such as no polemical writer has ever surpassed.

During the years which immediately followed the Restoration, Bunyan's confinement seems to have been strict. But as the passions of 1660 cooled, as the hatred with which the Puritans had been regarded while their reign was recent gave place to pity, he was less and less harshly treated. The distress of his family, and his own patience, courage, and piety, softened the hearts of his persecutors. Like his own Christian in the cage, he found protectors even among the crowd at Vanity Fair. The bishop of the diocese, Dr Barlow, is said to have interceded for him. At length the prisoner was suffered to pass most of his time beyond the walls of the jail, on condition, as it should seem, that he remained within the town of Bedford.

He owed his complete liberation to one of the worst acts of one of the worst governments that England has ever seen. In 1671 the Cabal was in power. Charles II. had concluded the treaty by which he bound himself to set up the Roman Catholic religion in England. The first step which he took towards that end was to annul, by an unconstitutional exercise of his prerogative, all the penal statutes against the Roman Catholics; and in order to disguise his real design, he annulled at the same time the penal statutes against Protestant Nonconformists. Bunyan was consequently set at large. In the first warmth of his gratitude he published a tract, in which he compared Charles to that humane and generous Persian king, who, though not himself blessed with the light of the true religion, favoured the chosen people, and permitted them, after years of captivity, to rebuild their beloved temple. To candid men, who consider how much Bunyan had suffered, and how little he could guess the secret designs of the court, the unsuspicious thankfulness with which he accepted the precious boon of freedom will not appear to require any apology.

Before he left his prison he had begun the book which has made his name immortal. The history of that book is remarkable. The author was, as he tells us, writing a treatise, in which he had occasion to speak of the stages of the Christian progress. He compared that progress, as many others had compared it, to a pilgrimage. Soon his quick wit discovered innumerable points of similarity which had escaped his predecessors. Images came crowding on his mind faster than he could put them into words, quagmires and pits, steep hills, dark and horrible glens, soft vales, sunny pastures, a gloomy castle, of which the courtyard was strewn with the skulls and bones of murdered prisoners, a town all bustle and splendour, like London on the Lord Mayor's Day, and the narrow path, straight as a

rule could make it, running on up hill and down hill, through city and through wilderness, to the Black River and the Shining Gate. He had found out, as most people would have said, by accident, as he would doubtless have said, by the guidance of Providence, where his powers lay. He had no suspicion, indeed, that he was producing a masterpiece. He could not guess what place his allegory would occupy in English literature; for of English literature he knew nothing. Those who suppose him to have studied the *Faery Queen* might easily be confuted, if this were the proper place for a detailed examination of the passages in which the two allegories have been thought to resemble each other. The only work of fiction, in all probability, with which he could compare his *Pilgrim* was his old favourite, the legend of Sir Bevis of Southampton. He would have thought it a sin to borrow any time from the serious business of his life from his expositions, his controversies, and his lace tags, for the purpose of amusing himself with what he considered merely as a trifle. It was only, he assures us, at spare moments that he returned to the House Beautiful, the Delectable Mountains, and the Enchanted Ground. He had no assistance. Nobody but himself saw a line till the whole was complete. He then consulted his pious friends. Some were pleased. Others were much scandalized. It was a vain story, a mere romance, about giants, and lions, and goblins, and warriors, sometimes fighting with monsters, and sometimes regaled by fair ladies in stately palaces. The loose atheistical wits at Will's might write such stuff to divert the painted Jezebels of the court; but did it become a minister of the gospel to copy the evil fashions of the world? There had been a time when the cant of such fools would have made Bunyan miserable. But that time was past; and his mind was now in a firm and healthy state. He saw that in employing fiction to make truth clear and goodness attractive, he was only following the example which every Christian ought to propose to himself; and he determined to print.

The *Pilgrim's Progress* stole silently into the world. Not a single copy of the first edition is known to be in existence.[1] The year of publication has not been ascertained. It is probable that during some months the little volume circulated only among poor and obscure sectaries. But soon the irresistible charm of a book which gratified the imagination of the reader with all the action and scenery of a fairy tale, which exercised his ingenuity by setting him to discover a multitude of curious analogies, which interested his feelings for human beings, frail like himself, and struggling with temptations from within and from without, which every moment drew a smile from him by some stroke of quaint yet simple pleasantry, and nevertheless left on his mind a sentiment of reverence for God and of sympathy for man, began to produce its effect. In puritanical circles, from which plays and novels were strictly excluded, that effect was such as no work of genius, though it were superior to the *Iliad*, to *Don Quixote*, or to *Othello*, can ever produce on a mind accustomed to indulge in literary luxury. In 1678 came forth a second edition with additions; and then the demand became immense. In the four following years the book was reprinted six times. The eighth edition, which contains the last improvements made by the author, was published in 1682, the ninth in 1684, the tenth in 1685. The help of the engraver had early been called in; and tens of thousands of children looked with terror and delight on execrable copperplates, which represented Christian thrusting his sword into Apollyon, or writhing in the grasp of Giant Despair. In Scotland, and in some of the colonies, the *Pilgrim* was even more popular than in his native country. Bunyan has told us, with very pardonable vanity, that in New England his dream was the daily subject of the conversation of thousands, and was thought worthy to appear in the most superb binding. He had numerous admirers in Holland, and among the Huguenots of France. With the pleasures, however, he experienced some of the pains of eminence. Knavish booksellers put forth volumes of trash under his name, and envious scribblers maintained it to be impossible that the poor ignorant tinker should really be the author of the book which was called his.

He took the best way to confound both those who counterfeited him and those who slandered him. He continued to work the gold-field which he had discovered, and to draw from it new treasures, not indeed with quite such ease and in quite such abundance as when the precious soil was still virgin, but yet with success, which left all competition far behind. In 1684 appeared the second part of the *Pilgrim's Progress*. It was soon followed by the *Holy War*, which if the *Pilgrim's Progress* did not exist, would be the best allegory that ever was written.

Bunyan's place in society was now very different from what it had been. There had been a time when many dissenting ministers, who could talk Latin and read Greek, had affected to treat him with scorn. But his fame and influence now far exceeded theirs. He had so great an authority among the Baptists that he was popularly called Bishop Bunyan. His episcopal visitations were annual. From Bedford he rode every year to London, and preached there to large and attentive congregations. From London he went his circuit through the country, animating the zeal of his brethren, collecting and distributing alms, and making up quarrels. The magistrates seem in general to have given him little trouble. But there is reason to believe that, in the year 1685, he was in some danger of again occupying his old quarters in Bedford jail. In that year the rash and wicked enterprise of Monmouth gave the Government a pretext for prosecuting the nonconformists; and scarcely one eminent divine of the Presbyterian, Independent, or Baptist persuasion remained unmolested. Baxter was in prison: Howe was driven into exile: Henry was arrested. Two eminent Baptists, with whom Bunyan had been engaged in controversy, were in great peril and distress. Danvers was in danger of being hanged; and Kiffin's grandsons were actually hanged. The tradition is that, during those evil days, Bunyan was forced to disguise himself as a waggoner, and that he preached to his congregation at Bedford in a smock-frock, with a cart-whip in his hand. But soon a great change took place. James the Second was at open war with the church, and found it necessary to court the dissenters. Some of the creatures of the Government tried to secure the aid of Bunyan. They probably knew that he had written in praise of the indulgence of 1672, and therefore hoped that he might be equally pleased with the indulgence of 1687. But fifteen years of thought, observation, and commerce with the world had made him wiser. Nor were the cases exactly parallel. Charles was a professed Protestant; James was a professed Papist. The object of Charles's indulgence was disguised; the object of James's indulgence was patent. Bunyan was not deceived. He exhorted his hearers to prepare themselves by fasting and prayer for the danger which menaced their civil and religious liberties, and refused even to speak to the courtier who came down to remodel the corporation of Bedford, and who, as was supposed, had it in charge to offer some municipal dignity to the bishop of the Baptists.

Bunyan did not live to see the Revolution. In the summer of 1688 he undertook to plead the cause of a son

[1] A copy has been discovered in very recent times, and a fac-simile reprint of it was published in 1875.

with an angry father, and at length prevailed on the old man not to disinherit the young one. This good work cost the benevolent intercessor his life. He had to ride through heavy rain. He came drenched to his lodgings on Snow Hill, was seized with a violent fever, and died in a few days (August 31). He was buried in Bunhill Fields; and the spot where he lies is still regarded by the Nonconformists with a feeling which seems scarcely in harmony with the stern spirit of their theology. Many Puritans, to whom the respect paid by Roman Catholics to the reliques and tombs of saints seemed childish or sinful, are said to have begged with their dying breath that their coffins might be placed as near as possible to the coffin of the author of the *Pilgrim's Progress.*

The fame of Bunyan during his life, and during the century which followed his death, was indeed great, but was almost entirely confined to religious families of the middle and lower classes. Very seldom was he during that time mentioned with respect by any writer of great literary eminence. Young coupled his prose with the poetry of the wretched D'Urfey. In the *Spiritual Quixote,* the adventures of Christian are ranked with those of Jack the Giant-Killer and John Hickathrift. Cowper ventured to praise the great allegorist, but did not venture to name him. It is a significant circumstance that, till a recent period, all the numerous editions of the *Pilgrim's Progress* were evidently meant for the cottage and the servant's hall. The paper, the printing, the plates, were all of the meanest description. In general, when the educated minority and the common people differ about the merit of a book, the opinion of the educated minority finally prevails. The *Pilgrim's Progress* is perhaps the only book about which, after the lapse of a hundred years, the educated minority has come over to the opinion of the common people.

The attempts which have been made to improve and to imitate this book are not to be numbered. It has been done into verse; it has been done into modern English. The Pilgrimage of Tender Conscience, the Pilgrimage of Good Intent, the Pilgrimage of Seek Truth, the Pilgrimage of Theophilus, the Infant Pilgrim, the Hindoo Pilgrim, are among the many feeble copies of the great original. But the peculiar glory of Bunyan is that those who most hated his doctrines have tried to borrow the help of his genius. A Catholic version of his parable may be seen with the head of the virgin in the title-page. On the other hand, those Antinomians for whom his Calvinism is not strong enough, may study the Pilgrimage of Hephzibah, in which nothing will be found which can be construed into an admission of free agency and universal redemption. But the most extraordinary of all the acts of Vandalism by which a fine work of art was ever defaced was committed so late as the year 1853. It was determined to transform the *Pilgrim's Progress* into a Tractarian book. The task was not easy; for it was necessary to make two sacraments the most prominent objects in the allegory, and of all Christian theologians, avowed Quakers excepted, Bunyan was the one in whose system the sacraments held the least prominent place. However, the Wicket Gate became a type of Baptism, and the House Beautiful of the Eucharist. The effect of this change is such as assuredly the ingenious person who made it never contemplated. For, as not a single pilgrim passes through the Wicket Gate in infancy, and as Faithful hurries past the House Beautiful without stopping, the lesson which the fable in its altered shape teaches, is that none but adults ought to be baptized, and that the Eucharist may safely be neglected. Nobody would have discovered from the original *Pilgrim's Progress* that the author was not a Pædobaptist. To turn his book into a book against Pædobaptism, was an achievement reserved for an Anglo-Catholic divine. Such blunders must necessarily be committed by every man who mutilates parts of a great work, without taking a comprehensive view of the whole. (M.)

Bunyan's works were first published in a collected form in 1692 (2 vols. folio). Of more recent editions, one of the best is that by George Offor (3 vols. 8vo, 1853). The *Pilgrim's Progress* has probably passed through a larger number of editions than any other book except the Bible. Southey's edition (1830) contains a life of Bunyan, which was afterwards (1839) published separately.

BUNZLAU (1.), the chief town of a circle in the government of Liegnitz in Prussian Silesia, on the right bank of the Bober, about 27 miles from the city of Liegnitz by the Berlin and Breslau Railway, which crosses the river by a noble viaduct. The older part of the town is still surrounded with fortifications. Its public institutions comprise a gymnasium, a normal college, an orphan asylum, and the provincial lunatic asylum. The house is shown where Opitz was born in 1597, and in the market-place is a cast-iron obelisk to field-marshal Kutusoff. The Bunzlau pottery is famous; woollen and linen cloth are manufactured, and there is a considerable trade in grain and cattle. Bunzlau (Boleslavia) received its name in the 12th century from Duke Boleslas, who separated it from the duchy of Glogau. Its importance was increased by numerous privileges and the possession of extensive mining works. It was frequently captured and recaptured in the wars of the 17th century, and in 1739 was completely destroyed by fire. In 1813 it was the scene of a battle between the French and the Allies. Population in 1871, 8812.

BUNZLAU (2.), the chief town of a circle in Bohemia, on the left bank of the Iser, in 50° 25′ N. lat. and 14° 54′ E. long. It has a town-house and castle, supposed to have been built in the 10th century—which is now used as barracks,—a military hospital, a Piaristic college, and a gymnasium. Its manufactures include cotton, woollen, and linen cloth, leather, and soap. Bunzlau is frequently called Jung Bunzlau to distinguish it from Alt Bunzlau, a village on the Elbe. Population (1869), 8695.

BUONAFEDE, Appiano (1716–1793), an Italian writer on philosophy and social economy, was born at Comachio, in Ferrara, in 1716. He became professor of theology at Naples in 1740, and entering the religious body of the Celestines in 1734, rose gradually to be general of the order. He died at Rome in 1793. His principal works, generally published under the assumed title of *Agatopisto Cromaziano,* are on the history of philosophy, *Della Istoria e delle Indole di ogni Filosofia,* 7 vols., 1772, *seq.;* and *Della Restaurazione di ogni Filosofia ne' Secoli* xvi., xvii., xviii., 3 vols., 1789 (which has been translated into German by Heydenreich). The second of these is of great importance for the estimation of the Italian philosophers of the 16th century. His other works are *Istoria critica e filosofica del suicidio,* 1761; *Delle conquiste celebri esaminate col naturale diritto delle genti,* 1763; *Storia critica del moderno diritto di natura e delle genti,* 1789; and a few poems and dramas.

BUONARROTI. See Michel Angelo.

BUOY, a floating body used as a means of denoting any desired spot in a river, channel, or other place frequented by shipping. Buoys are made of various shapes and material, such as a small log of wood 6 or 8 inches diameter and about twice that length, an ordinary cask, or a special structure either of iron or wood, varying in strength, shape, and size according to the duty it is required to perform. Before an anchor is let go, a buoy is generally attached to it, the length of the buoy-rope being slightly greater than the depth of water at high tide. This is done that if for any reason it should become necessary to slip the cable, both anchor and cable may be afterwards recovered

the more readily, their position being denoted by the buoy, and also because it is of service to know the position of the anchor before attempting to weigh it. The buoys most commonly used for this purpose are of the shape of two cones brought together at their bases, and are made of sheet iron, usually galvanized; they are called *Nun-buoys.*

Mooring-buoys are placed in convenient positions so that ships may make fast to them instead of dropping their anchors, and are generally provided with large ring and eye bolts for this purpose. Such buoys are usually of a cylindrical shape, and are made either of iron or wood. They must have sufficient buoyancy to support the weight of a cable of the required strength for the size of ship it is intended to moor, and at the same time be high enough out of the water to make themselves conspicuous. One of the largest and most approved mooring buoys recently made consisted of a cylinder 9 feet long and 6 feet 9 inches diameter, the edges of the ends being rounded off; it was made of iron plates $\frac{3}{8}$ inch thick, and was divided into two water-tight compartments by an iron flat passing through the axis of the cylinder; a watertight iron trunk was fitted, passing through the buoy at the centre, at right angles to the flat, for the cable to go through, so that it might be secured on the upper surface of the buoy.

Buoys are also used to mark the positions of sands and shoals. A usual shape given to them in rivers and sheltered places is that of a frustum of a cone, the smaller end being placed downwards, and the name of the buoy—a name which indicates the shoal it marks—being painted in large letters on the upper end. In more exposed positions the buoys have to be larger and stronger, and are usually made of an egg-shape flattened at the bottom. The largest and most approved are made of iron plates $\frac{1}{2}$ inch and $\frac{3}{8}$ inch thick, with a smaller buoy of similar shape, built within the larger one, so as to divide it into two water-tight compartments. The advantage of the division in this case, and in the case of the mooring buoy described above, is, that the buoy is less liable to be sunk by collision with passing vessels, since if one compartment is damaged the other has sufficient buoyancy to float the whole. The largest of these buoys are about 15 feet 6 inches high, and 10 feet diameter at the widest part, the inner buoy being 9 feet high and 8 feet diameter.

A bell which is frequently placed on a buoy is of great service at night or in foggy weather, the motion of the buoy as it is tossed about by the waves causing the bell to ring.

BUPALUS AND ATHENIS, Greek sculptors, about 540 B.C., lived in the island of Chios, which at that time had a school of sculptors who had acquired some celebrity by their works in marble, which material they had introduced as a substitute for the bronze and wood previously employed for sculpture. Bupalus was the more celebrated of the two brothers. Their father was Archermus, also a sculptor; and it seems from the few notices of their works which exist, that they produced only draped figures, from which it is inferred that their art had not yet advanced to the study of the human figure itself. The Graces, who are now only known as nude figures, were represented as draped by Bupalus for the Temple of Nemesis in Smyrna. He is said also to have made a figure of Tyche (Fortune) for that town. They worked apparently only for the towns in Asia Minor and the Greek islands. Yet Pliny (*Nat. Hist.* xxxvi. 11) says that sculptures from their hands were to be seen in the pediment of the temple of Apollo on the Palatine at Rome, whither they had been brought by Augustus, who seems to have had a taste for early Greek work. But if this is true, and if the figures at all fitted into the peculiar space of a temple pediment, it would follow that they had originally been designed for a similar purpose, and that, therefore, these early artists were able to produce figures for architectural decoration, which hardly seems probable. There is a story that Bupalus had made a caricature portrait of the poet Hipponax, who was known for his ugliness, and that the poet replied by some verses, the sting of which caused the sculptor to hang himself.

BUPHONIA, called also DIIPOLIA, a religious festival held on the 14th of the month Skirophorion (July) at Athens, when the very ancient ceremony was gone through of sacrificing an ox to Zeus, under the following circumstances.—The ox was driven forward to the altar, on which grain was spread, by members of the family of the Kentriadæ, on whom this duty devolved hereditarily (κέντρον, from which the name is derived, means a goad). When it began to eat, one of the family of the Thaulonidæ advanced with an axe, slew the ox, then immediately threw away the axe, and fled. The axe was now carried before the court of the Prytaneum (see AREOPAGUS), and there charged with having caused the death of the ox, for which it was thrown into the sea. Meantime the sacrifice of the ox was accepted in the usual manner.

BURCKHARDT, JOHN LUDWIG (1784–1817), a celebrated Swiss traveller, was born at Kirchgarten, near Lausanne, November 24, 1784. After studying at Leipsic and Göttingen he visited England in the summer of 1806, carrying a letter of introduction from the celebrated Blumenbach to Sir Joseph Banks, who, with the other members of the African Association, accepted his offer to explore the interior of Africa. After studying in London and Cambridge, and inuring himself to all kinds of hardships and privations, he left England in April 1809 for Malta, whence he proceeded, in the following October, to Aleppo. In order that he might acquire Arabic thoroughly he disguised himself as a Mussulman, under the name of Sheik Ibrahim Ibn Abdallah; and, after two years passed in that part of Asia, he had so mastered the language as not to be distinguished from the natives, and had acquired such accurate knowledge of the contents of the Koran, and of the commentaries upon its religion and laws, that after a critical examination the most learned Mussulmans entertained no doubt of his being really what he professed to be, a learned doctor of their law. During his residence in Syria he visited Palmyra, Damascus, Lebanon, and thence repaired to Cairo with the intention of joining a caravan, and travelling to Fezzan, in the north of Africa. In 1812, whilst waiting for the departure of the caravan, he undertook a journey to the Nile, as far up as Mahass; and then, in the character of a poor Syrian merchant, he made a journey through the Nubian desert which Bruce had traversed, passing by Berber and Shendy to Suakin, on the Red Sea, whence he performed the pilgrimage to Mecca by way of Jiddah. After enduring privations and sufferings of the severest kind, he returned to Cairo in a state of great exhaustion; but in the spring of 1816 he travelled to mount Sinai, whence he returned to Cairo in June, and there made preparations for his intended journey to Fezzan, and exploration of the sources of the Niger. Several hindrances prevented his prosecuting this intention, and finally, in April 1817, when the long expected caravan prepared to depart, he was seized with an illness of which he died in October. He had from time to time carefully transmitted to England his journals and remarks, and a very copious series of letters, so that nothing which appeared to him to be interesting in the various journeys he made has been lost. He bequeathed his collection of 800 vols. of Oriental MSS. to the library of Cambridge university.

His works were, *Travels in Nubia*, 1819; *Travels in Syria and the Holy Land*, 1822; *Travels in Arabia*, 1829; *Notes on the Bedouins and Wahabys*, 1830; *Arabic Proverbs*, 1830.

BURDER, GEORGE, one of the founders of the London Missionary Society, was born in London, June 5, 1752,

and died there May 29, 1832. He was pastor of the Independent church at Lancaster from 1778 to 1783. Afterwards, he was for twenty years minister of the West Orchard chapel at Coventry. At the end of this period he removed to London, where for twenty-nine years he officiated at the Fetter Lane chapel. For many years he performed gratuitously the duties of secretary to the London Missionary Society, and edited, with much success, the *Evangelical Magazine*. He is chiefly remembered now as the author of the *Village Sermons*, which appeared at intervals from 1799 to 1812, and were at last completed in six volumes. They have had an extraordinarily wide circulation, and have passed through numerous editions. He edited many works,—among others the *Pilgrim's Progress*, Collings's *Weaver's Pocket-book, or Weaving Spiritualized*, and Henry's *Bible with Improvements*.

BURDETT, Sir Francis (1770–1844), Baronet, was born on the 25th of January 1770. The rudiments of his education he received at Westminster school, whence he removed in due time to Oxford. He did not wait to graduate at that university, but in 1790 set out on a Continental tour, in the course of which he became strongly imbued with the revolutionary principles then dominant in France and other countries. On his return to England in 1793 he married the youngest daughter of Thomas Coutts, a London banker, with whom he received a large fortune. In 1796, through the influence of the duke of Newcastle, he was chosen M.P. for Boroughbridge, on which occasion he had as colleague John Scott, afterwards Lord Eldon. In 1797 he succeeded his grandfather in the baronetcy, his father and elder brother having predeceased him. At the outset of his political career he was a zealous supporter of ultra-liberal measures. In 1802, after a protracted contest, he was elected M.P. for Middlesex, in opposition to the former member, Mr Mainwaring. The election, however, was declared void, and in the subsequent canvass he was defeated. In 1806 he again stood for Middlesex and was again defeated, but when he stood for Westminster in the same year he was elected by a large majority. In March 1810 he wrote a letter to his constituents, denying the right of Government to commit for libel, as they had recently done. This letter was brought under the notice of the House, and the speaker issued a warrant for the committal of Sir Francis to the Tower. The baronet, however, disputed the right of the House, and had to be removed from his own residence by force. There was some collision in consequence between the military and the populace who were devoted to Sir Francis. At the prorogation of parliament he was released, and lost no time in prosecuting the Speaker and the Sergeant-at-arms, but without success. On the occasion of the Manchester riots in 1819 he wrote a letter to his constituents, for which he was tried for libel, found guilty, and condemned to three months' imprisonment, and to pay a fine of £1000. In 1837 he ceased to represent Westminster, and when he was returned for North Wiltshire he joined the Conservative party, which he supported during the remainder of his political career. He died January 23, 1844.

BURG, a town of Prussian Saxony, on the River Ihle, and on the railway from Berlin to Magdeburg, 14 miles N.E. of the latter. It has long been noted for its woollen manufactures, which afford employment to a great part of its population. The town formerly belonged to the Querfurt principality, but was ceded to Brandenburg in 1687. It owes its prosperity to the large influx of industrious French, Palatinate, and Walloon refugees, which took place in the end of the 17th century. Population in 1871, 15,184.

BURGAGE is a form of tenure, both in England and Scotland, applicable to the property connected with the old municipal corporations and their privileges. The term is of less practical importance in the English than in the Scottish system, where it still holds an important place in the practice of conveyancing, real property being there generally divided into feudal-holding and burgage-holding. It is usual to speak of the English burgage-tenure as a relic of Saxon freedom resisting the shock of the Norman conquest and its feudalism, but it is perhaps more correct to consider it a local feature of that general exemption from feudality enjoyed by the *municipia* as a relic of their ancient Roman constitution. The reason for the system preserving its specifically distinct form in Scottish conveyancing is because burgage-holding was an exception to the system of subinfeudation which remained prevalent in Scotland when it was suppressed in England. While other vassals might hold of a graduated hierarchy of overlords up to the crown, the burgess always held directly of the sovereign. It is curious that while in England the burgage-tenure was deemed a species of soccage, to distinguish it from the military holdings, in Scotland it was strictly a military holding, by the service of watching and warding for the defence of the burgh. In England the franchises enjoyed by burgesses, freemen, and other consuetudinary constituencies in burghs, were dependent on the character of the burgage-tenure.

BURGDORF (in French, Berthoud), a town in the Swiss canton of Bern, on the River Emme, about 14 miles by railway from the chief city. It is situated 1840 feet above the level of the sea, and consists of an upper and lower part, which are connected by a spiral arrangement of streets. Its houses are substantially built, and it has an ancient castle, a town-house, a hospital, an orphanage, and a public library. Ribbons and damask, tobacco and chocolate are manufactured; and a large trade is carried on in the dairy produce of the Emmenthal. From the Lueg about $4\frac{1}{2}$ miles to the N.E. a view of the whole Bernese Alps can be obtained. The castle of Burgdorf was built at a very early date, and the town became the capital of Lesser Burgundy and the residence of the dukes of Zähringen. In 1270 they were succeeded by the lords of Kyburg, who, in 1326, pawned their possessions to Ulrich of Signan. In 1384 the town and countship were purchased by Bern for 37,000 florins, and the Bernese magistrates held rule till 1798. Pestalozzi had his educational establishment in the castle for a number of years. Population in 1870, 5078.

BÜRGER, Gottfried August (1748–1794), a celebrated German poet, was born on the 1st of January 1748 at Wolmerswende, a village in the principality of Halberstadt, where his father was Lutheran minister. In his childhood he showed little inclination to study; the Bible was the only book which had any attraction for him, and his first attempts in versification were imitations of the Psalms. It is to this first direction of his studies that we are to attribute the Biblical phrases, and the allusions to Christianity, which we find even in his amatory poetry. He was fond of solitude, and indulged in all the romantic sentiments which deserts and the gloom of forests inspire. From the school of Aschersleben, where his maternal grandfather resided, and which he quitted in consequence of receiving a severe chastisement for composing an epigram, he was sent to the institution at Halle. But at neither of these places did he make much progress, having a taste only for the lessons in prosody and versification. In 1764 Bürger, who was intended for the clerical office, began to attend the course of lectures given by the professors of the university. Klotz, a learned classical scholar, admitted him into the select number of the young men whose talents he took a pleasure in cultivating; but this society appears not to have produced the same favourable effect on the

moral character of Bürger as on his genius. His conduct prejudiced his grandfather Bauer against him; and it was with difficulty that he obtained from him some further assistance, with permission, in the year 1768, to repair to Göttingen to prosecute the study of the law. This change did not make him more regular in his studies; his morals became corrupted; and his grandfather withdrew his protection. Bürger contracted debts; and his situation would have become altogether desperate had not some friends interfered to assist him. An association, memorable in the annals of German literature, and into which Bürger was now admitted, had just been formed at Göttingen; it reckoned among its members Boje, Biester, Sprengel, Hölty, Müller, Voss, the two Counts Stolberg, C. F. Cramer, and Leisewitz. All of these were persons versed in Greek and Roman literature, and at the same time they all idolized Shakespeare. Bürger, in a great measure, owed his style to the enthusiasm which he showed, in common with his literary friends, for our great dramatist. The *Reliques of Ancient English Poetry*, published about this time by Dr Percy, gave an additional impulse to the direction which his mind had taken, and suggested to him some of his most admired productions. Of all his friends, Boje was the one who exercised the greatest influence over him in the choice and treatment of his subjects; and it is to his severe observations that the poetical stanza of Bürger owes a great part of that elegance and roundness which characterize it. To the same friend he was indebted also for some improvement in his circumstances. On the recommendation of Boje he was appointed to the collectorship of Altengleichen, in the principality of Calenberg. The following winter, some fragments of a ghost story, which he heard a peasant girl singing by moonlight, caught his imagination, and suggested his celebrated ballad of *Leonora*. This remarkable production at once established his reputation as a poet. About this time he married a Hanoverian lady, named Leonhart; but this union proved only a source of bitterness, as an unhappy attachment to her younger sister soon after sprung up in his heart. The loss of a sum of money, of which his grandfather had made him a present, was the first commencement of his embarrassments; the taking of a large farm, which he did not know how to manage, increased them. The dismissal from his place, in 1784, in consequence of suspicions (probably ill-founded) raised against the fidelity of his accounts, gave the finishing stroke to his misfortunes. He had a little before lost his wife, whose death was hastened by the culpable passion which Bürger cherished in his heart. Left with two children, and reduced to the inconsiderable emoluments of *The Almanack of the Muses*, which he had edited since 1779, he removed to Göttingen with a view to giving private lessons there, and in the hope of obtaining a professor's chair in the department of belles-lettres. Five years later the title was conferred on him, but without a salary; and this was the only public recompense obtained during his whole life by a man who was one of the favourite authors of his nation, and who, while yet young, had achieved the highest reputation. Scarcely were the ashes of his wife cold when he espoused her sister, whose name his poems have made but too famous. She died in childbed in the beginning of 1786. From that moment his own life only lingered on; and the fire of his genius seemed extinguished with the passion which had so long nourished it. He had scarcely strength enough, in the intervals of his dejection, to finish his *Song of Songs*, a sort of dithyrambic or nuptial hymn, intended to celebrate his second marriage, and which is a strange mixture of frantic passion, religious devotion, and the most bombastic expression. It was the last production of Bürger.

Having studied the philosophy of Kant, he had an idea of deriving some advantage from it at Göttingen, where it had not yet been taught. He undertook to explain it in a course of lectures, which were attended by a great number of students. The satisfaction which the university expressed to him for two cantatas which he composed in 1787, on the occasion of the fifty years' jubilee of this illustrious institution, and his appointment to the situation of professor extraordinary, reanimated his spirits. Fortune appearing to smile on him once more, he formed the design of marrying again. During one of the moments when he was most occupied with this idea he received a letter from Stuttgart, in which a young woman, whose style indicated a cultivated mind, and her sentiments an elevated and feeling heart, after describing to him with enthusiasm the impression which his poetry had made upon her, offered him her hand and heart. The information which he received respecting the character, the fortune, and personal accomplishments of his correspondent having excited his curiosity, he took a journey to Stuttgard, and brought back with him a wife who embittered and dishonoured the rest of his days. In less than three years he saw himself under the necessity of obtaining a divorce from her; and the ruin of his health aggravated the absolute disorder of his finances. Confined to a small chamber, the favourite poet of Germany wasted the remainder of his strength in translations for foreign booksellers; but sickness and grief soon deprived him even of this resource, and he must have died in a state of the most abject poverty if the Government of Hanover had not relieved his necessities. He died June 8, 1794, in the forty-seventh year of his age.

Bürger is only remarkable as a lyric poet; for after having tried all the different species of this class of compositions, he has succeeded eminently only in the song and the ballad. We shall perhaps characterize his genius sufficiently by saying that his imagination is more fresh than rich,—that he has more sensibility than elevation, more naiveté and good nature than delicacy or taste. His style is striking from its clearness and its energy, and an elegance which is rather the result of labour than of natural grace; he possesses, in short, all the qualities which please the multitude. Allowing the title of poet only to those whose writings were calculated to become popular, he early habituated himself to reject whatever appeared to him not sufficiently intelligible and interesting to all classes of readers. He is always clear and forcible; and if at certain times there appears a want of selection and care in the details, yet the sentiments are uniformly noble, and the moral purpose of the majority of his pieces is irreproachable. Of the first three editions of Bürger's works, published at Göttingen, two appeared in 1778 and 1789, in 3 vols. 8vo; and the third, after his death, was published by his friend Ch. Reinhard, in 4 vols., 1796. Later editions of his poems are very numerous.

BURGERSDYK, or BURGERSDICIUS, FRANCIS, a celebrated Dutch logician, was born at Lier, near Delft, in 1590, and died at Leyden in 1629, in the thirty-ninth year of his age. He studied at the university of Leyden, and after completing his academical career there with great distinction, travelled through Germany and France. On arriving at Saumur in the latter country he began to study theology, and was so successful, that, while still a very young man, he was appointed professor of philosophy in that town. This office he held for five years, at the end of which period he returned to Leyden, where he accepted the chair of logic and moral philosophy, and afterwards that of natural philosophy. His *Logic* was at one time widely used, and is still a very valuable compendium. His treatise on ethics, entitled *Idea Philosophiæ Moralis*, was published posthumously in 1644.

BURGESS, DANIEL (1645–1712), a learned and witty dissenting divine of the 17th century, born at Staines,

in Middlesex, of which parish his father was minister. He was educated at Westminster school, and in 1660 was sent to Magdalen Hall, Oxford, but not being able conscientiously to subscribe the necessary formulæ, he quitted that university without taking his degree. In 1667, after taking orders, he was appointed by Lord Orrery to the head-mastership of a school recently established by that nobleman at Charleville in Munster, and soon after he became private chaplain to Lady Mervin, near Dublin. On his return from Ireland he openly avowed his Presbyterian principles, and frequently preached in contempt of the severe laws against nonconformity. For these offences he was imprisoned, but soon regaining his liberty he went to London, where he speedily collected a large congregation, as much by the somewhat fanatical fervour of his piety as by the ludicrous illustrations which he frequently employed in his sermons. Besides preaching, he gave instructions to private pupils, of whom the most distinguished was Henry St John, afterwards Lord Bolingbroke.

BURGESS, THE RIGHT REV. THOMAS (1756–1837), bishop of Salisbury, was born at Odiham, in Hampshire. He was educated at Winchester, and in 1775 he removed to Oxford, where he gained a scholarship at Corpus Christi College. Before graduating, he edited a reprint of Burton's *Pentalogia*. In 1781 he brought out an edition of Dawes's *Miscellanea Critica*, with numerous annotations, a work so favourably received on the Continent that it was reprinted *verbatim* at Leipsic in 1800. In 1783 he became a fellow of his college, and two years later undertook a journey to Holland, where he prosecuted his researches for some time. On his return he was appointed chaplain to Shute Barrington, bishop of Salisbury, through whose influence he obtained a prebendal stall in the cathedral of that town. In 1789 he published his *Considerations on the Abolition of Slavery*, in which he advocated the principle of gradual emancipation. From Salisbury he removed to Durham, where he effected much good among the poorer classes, by publishing and distributing suitable religious works. In 1803 he was promoted by his old schoolfellow Addington, then prime minister, to the vacant see of St David's, which he held for twenty years, and where he gave evidence of his philanthropic disposition by establishing the Society for the Promotion of Christian Knowledge, and founding the College of Lampeter, which he liberally endowed. In 1820 he was appointed first president of the Royal Society of Literature recently founded; and three years later he was promoted to the see of Salisbury, over which he presided for twelve years, prosecuting his benevolent designs with unwearied industry. One of the most important of the many services which he rendered to the church, was the establishment of a Church Union Society for the assistance of infirm and distressed clergymen, to which he bequeathed £3000. In the midst of his useful and laborious career, he was cut off by an attack of dropsy, February 19, 1837. He bequeathed his library and a large sum of money to Lampeter College. A list of his works, which are very numerous, will be found in his biography by J. S. Harford, 2d ed., 1841. In addition to those already referred to may be mentioned his *Essay on the Study of Antiquities, The First Principles of Christian Knowledge; Reflections on the Controversial Writings of Dr Priestley; Emendationes in Suidam et Hesychium et alios Lexicographos Græcos; The Bible, and nothing but the Bible, the Religion of the Church of England.*

BURGHLEY, WILLIAM CECIL, LORD. See CECIL.

BURGKMAIR, HANS or JOHN, a celebrated engraver on wood, believed to have been a pupil of A. Dürer, was born at Augsburg in 1473, and died about 1531. Professor Christ ascribes to him about 700 woodcuts, most of them distinguished by that spirit and freedom which we admire in the works of his supposed master. His principal work is the series of 135 prints representing the triumphs of the Emperor Maximilian I. They are of large size, executed in chiaroscuro, from two blocks, and convey a high idea of his powers. Burgkmair was also an excellent painter in fresco and in distemper, specimens of which are in the galleries of Munich and Vienna, carefully and solidly finished in the style of the old German school. See Kugler's *Handbook of Flemish, Dutch, and German Schools*, by Crowe.

BURGLARY, or NOCTURNAL HOUSE-BREAKING (*burgi latrocinium*), which by the ancient English law was called *hamesucken* (a word also used in the law of Scotland, but in a somewhat different sense), has always been looked upon as a very heinous offence. The definition of a burglar, as given by Sir Edward Coke, is "he that by night breaketh and entereth in a mansion-house with intent to commit a felony." The offence and its punishment are regulated by 24 and 25 Vict. c. 96. Night, for the purposes of that Act (sec. 1), is deemed to commence at nine o'clock in the evening of each day, and to conclude at six o'clock in the morning. Sec. 51 extends the definition of burglary to cases in which a person enters another's dwelling-house with intent to commit felony, or being in such house commits felony therein, and in either case *breaks out* of such dwelling-house by night. The punishment is penal servitude for life, or any term not less than five years, or imprisonment not exceeding two years, with or without hard labour and solitary confinement.

BURGOS, the capital formerly of the kingdom of Old Castile, and now of a separate province, stands on the slope of a hill, the base of which is skirted by the River Arlanzon, 75 miles from Madrid, in lat. 42° 21′ N., long. 3° 43′ W. It is a considerable town, consisting of about 1400 houses, originally girt into the form of a segment of a circle by a wall, some portions of which still remain. On the opposite bank of the river, and connected with the more ancient part of the town by three stone bridges, are the suburbs (Barrio de la Vega), tastefully laid out in pleasure-grounds, while lower down in the midst of the stream is an island furnished with seats and walks as a public promenade. The streets and squares are exceedingly irregular, although spacious and well built. The principal square is the Plaza Mayor, or Plaza de la Constitucion, in the centre of which is a bronze statue of Charles II. The most important public building is the cathedral, begun by Bishop Maurice, traditionally an Englishman, in 1221, but not completed till 1567. It is built in an irregular florid Gothic style, and contains eight chapels, the most famous of which is the Capilla del Condestable, containing the tombs of several of the Velasco family, the hereditary constables of Castile. (See View and Plan in Street's *Gothic Architecture of Spain*, and history by Orcajo, *Historia de la Catedral de Burgos*.) Besides the cathedral there is the Hotel de Ville, or *Casa de Ayuntamiento* (where the bones of the Cid and his wife are preserved in a walnut case), the Palace of Velasco, the church of St Paul, and a beautiful Doric arch, erected in honour of Fernando Gonzalez. There is a fine approach to the city through the massive gate of Santa Maria, surmounted by a statue of the Virgin and Child, and with figures of Fernando Gonzaléz, Charles I., the Cid, and Diego Porcelos in the niches. The hospitals of Burgos are seven in number, and well supported; they are the Hospital San Juan (founded in 1479), the Hospital de la Conception, San Julian, San Quirce, Del Rey, Militar, and the Hospicio y Casa de Epositos. The educational wants of the district are supplied by four primary schools, which are liberally endowed from the municipal funds, and give gratuitous instruction to a considerable number of pupils. There is also a normal school and

a Seminario Conciliar, in which the higher branches are taught. But the most important educational establishment is the Instituto Superior which has a staff of 21 professors, and annually enrols about 250 students. The university, founded in 1550 and restored in 1776, has been long defunct. Burgos is the see of an archbishop, who has for his suffragans the bishops of Pamplona, Palencia, Santander, and Tudela. It has several monasteries, amongst which may be mentioned San Pablo, built about 1415 and now occupied as a store; La Merced, converted into a hospital; the Monasterio de Fredesval, and others. About two miles distant from the town stands the Carthusian convent of Miraflores, built in room of an earlier erection about 1480-7; whilst a little below the promenade of the Isla stands the Santa Maria la Real de las Huelgas, founded by Alphonso VIII., the abbess of which was invested with almost royal prerogatives, and held an unlimited sway over more than fifty villages. Burgos is the official residence of a military staff, and is well provided with barracks and storehouses. The jurisdiction of its courts extends over the whole *audiencia*, including Alava, Guipuzcoa, Logroño, Santander, Soria, and Biscay.

Besides furnishing a mart for the agricultural produce of the neighbouring districts, Burgos carries on a considerable export trade in linen and woollen stuffs, made in imitation of English goods. The principal articles of manufacture are paper, hats, stockings, and leather goods. Its population, which is said at one time to have numbered 80,000, amounted to 25,721 at the census of 1860, which was an increase of 10,931 since 1845.

The history of Burgos cannot be carried back beyond the end of the 9th century. There is no trace of its existence during the occupation of Spain by the Romans. We find the nucleus of it existing in 884, when Diego Porcelos, at the command of Alphonso the Great, built a castle on the right bank of the Arlanzon to check the progress of the Moors. From that time forward it steadily increased in importance, reaching the height of its prosperity in the 15th century, when, alternately with Toledo, it was occupied as a royal residence, but rapidly declining when the court was finally removed to Madrid. Being on one of the principal military roads of the kingdom, it suffered severely during the Peninsular War. In 1808 it was the scene of the defeat of the Spanish army by the French under Marshal Soult. It was unsuccessfully besieged by Wellington in 1812, but was surrendered to him at the opening of the campaign of the following year. (See Waring, *Architectural Studies in Burgos.*)

BURGOYNE, JOHN, an English general in the American War of Independence, was born about 1730, and died in 1792. He is generally supposed to have been a natural son of Lord Bingley, but according to his latest biographer this is not the case. He entered the army when young, and made a runaway marriage with a daughter of the earl of Derby. In 1761 he sat in parliament for Midhurst, and in the following year he served as brigadier-general in Portugal. On the outbreak of the American war he was appointed to a command, and in 1777 he was at the head of the British reinforcements designed for the invasion of the colonies from Canada. In this disastrous expedition he gained possession of Ticonderoga and Fort Edward; but, pushing on, was detached from his communications with Canada, and hemmed in by a superior force at Saratoga. On the 17th October his troops, about 3500 in number, laid down their arms. The success was the greatest the colonists had yet had, and it proved the turning point in the war. The indignation in England against Burgoyne was great, but perhaps unjust. The general himself resigned all his appointments, and demanded a trial, but without avail. In 1782, however, he was restored to his rank, and made commander-in-chief in Ireland. His *Dramatic and Poetical Works* appeared in 2 vols., 1808. One comedy, *The Heiress*, kept the stage for long. (See De Fonblanque, *Political and Military Episodes from the Life and Correspondence of Right Hon. J. Burgoyne*, 1876.)

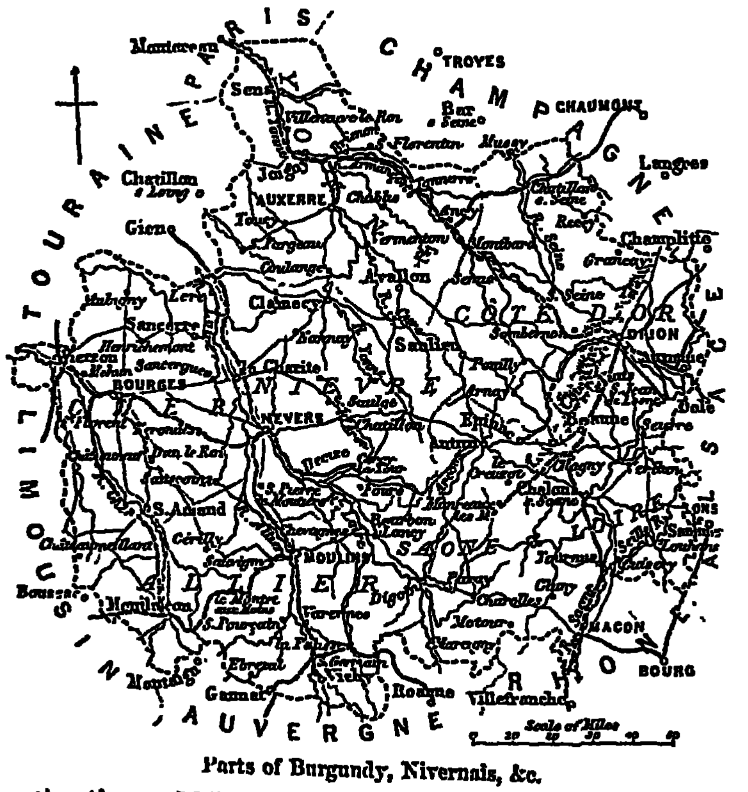
BURGOYNE, SIR JOHN FOX, son of the preceding, was born in 1782, and died October 7, 1871. He was educated at Eton and Woolwich, obtained a commission, and served in 1800 in Abercromby's expedition to the Mediterranean. He afterwards served in the Peninsular campaigns, but before the end of them was sent with Pakenham's division to New Orleans. During the years of peace Burgoyne took an active part in promoting the movement for national defences, and in 1845 was appointed Inspector-General of Fortifications. He was engaged at Alma, Balaklava, and Inkerman, and conducted the siege of Sebastopol till his recall in March 1855. After the conclusion of peace he received a baronetcy, and was made general, and in 1868 was raised to the rank of field-marshal.

BURGUNDIO, an illustrious jurist of the university of Pisa, sometimes erroneously styled Burgundius. He assisted at the Lateran Council in 1179 and died at a very advanced age in 1194. He was a distinguished Greek scholar, and is considered on the authority of Odofredus to have translated into Latin the various Greek fragments which occur in the Pandects, soon after the Pandects were brought to Bologna, with the exception of those in the 27th book, the translation of which has been attributed to Modestinus. The Latin translations which have been ascribed to Burgundio were received at Bologna as an integral part of the text of the Pandects, and form part of that known as *The Vulgate* in distinction from the Florentine text.

BURGUNDY (French, *Bourgogne*) has at various periods been the name of different political and geographical areas. The Burgundians (*Burgundi* or *Burgundiones*) seem to have been a people of German race, who are first found settled between the Oder and the Vistula. At an early period they came into conflict with the Alemanni, whom they defeated; and in the beginning of the 5th century they crossed into Roman Gaul under their leader Gundicar. The Romans not only permitted them to settle within the limits of the empire, but caused the inhabitants of the district to yield up to them one-half of their houses, two-thirds of the cultivated land, and a third of their slaves. The new-comers thus founded, in the country between the Aar and the Rhone, what is usually known as the first kingdom of Burgundy, which lasted till 534, when it was incorporated in the Frankish empire. Gundicar was succeeded in 436 by Gunderic, who somewhat extended his kingdom. In 470 it was parcelled out among his four sons—Chilperic, Gundibald, Godegisil, and Gondemar, who had their headquarters respectively at Geneva, Besançon, Lyons, and Vienne; but it was ultimately reunited in the hands of Gundibald, who is famous for his patronage of the Catholic ecclesiastics and his codification of the Burgundian law, which is consequently known as *Lex Gundibaldia*, or *Loi Gombette*. Gundibald was succeeded in 516 by his son Sigismund, who in turn gave place to Gundimar, the last of the dynasty. On the disintegration of the Carlovingian empire, Boson, the husband of Ermengarde, the daughter of the Emperor Louis II., founded the kingdom of Cisjuran or Lower Burgundy, but in 882 he recognized the overlordship of Charles the Stout. His territory included what was afterwards known as Franche Comté, a part of the later province of Burgundy, Dauphiné, Provence, and part of Languedoc and Savoy. In 888 Boson's example was followed by Rudolph, a Swiss count of Guelf race, who, supported by a large body of civil and ecclesiastical dignitaries called together by him at St Moritz in Valais, established a kingdom known as Transjuran or Upper Burgundy

His son, Rudolph, bartered his rights to the Italian crown for the Cisjuran kingdom, and thus united both Burgundies into what is frequently called the kingdom of Arles, which after various vicissitudes was finally united to the German empire by Conrad II. in 1033.

On the foundation of the Lower Burgundian kingdom by Boson, his brother Richard remained faithful to Charles the Bald of France, and was invested with the duchy of Burgundy, which had been held by various members of the Carlovingian family. King Robert II., however, took possession of it, and bestowed it in 1015 on his son, afterwards Henry I. On the accession of the latter to the throne of France, he gave the duchy to his brother Robert, with whose descendants it continued for a considerable period. In 1361 that elder line of dukes expired, and the duchy was seized by king John, and in 1363 presented by him to his son Philip the Bold as a reward for his bravery at the battle of Poitiers. Thus commenced that famous line of dukes which played so great a part in the history of France during the 14th and 15th centuries, and by the splendour of its achievements and the magnificence of its patronage rivalled the greatest dynasties of



Parts of Burgundy, Nivernais, &c.

the time. Philip's marriage with Margaret of Flanders brought him the countships of Burgundy (Franche Comté), Flanders, Artois, Réthel, and Nevers; and at a later period he purchased the countship of Charolais from the count of Armagnac. He was succeeded in 1404 by John the Fearless (*Jean sans Peur*), who was assassinated at the Bridge of Montereau in 1419, and left the duchy to his son Philip the Good. This duke survived till 1467, and during that time had greatly extended his territory. By very questionable proceedings he obtained possession of Hainault and Holland. Namur was purchased in 1429; and in the following year Brabant and Limburg also fell into his grasp. In 1435 there were further yielded to him, by treaty with France, Macon, Auxerre, Bar-sur-Seine, and various other towns in that district. His son, Charles the Bold, followed in the same course of territorial aggrandizement, and his ambitious projects gradually extended, till he began to aim at the founding of a great Gallo-Belgian kingdom; but his splendid plans came to an untimely end with his own death at the battle of Nancy in 1477, when he was trying to wipe off the disgrace inflicted on his arms by the Swiss at Morat. His daughter and heiress, Mary, married the Archduke Maximilian, son of Frederick III.; and with the exception of the duchy of Burgundy proper, which remained a fief of the French crown, brought with her all the vast inheritance of her father. In 1512 Maximilian incorporated the territory with the German empire under the title of the circle of Burgundy. It was gradually diminished by the encroachments of France, and by the liberation of the Netherlands, so that at the Revolution it only consisted of Brabant, Limburg, Luxembourg, and parts of Flanders, Hainault, Namur, and Guelders.

The duchy meanwhile had been raised with some additions to the rank of a province, and formed a military governorship. It was bounded on the N. by Champagne, E. by Franche Comté and Bresse, S. by Lyonnais and Dauphiné, and W. by Bourbonnais and Nivernais. It was divided into eight districts—Auxerrais, the country of the Mountain, Auxais, Dijonnais, Autunais, Châlonnais, Charolais, and Mâconnais. It possessed a separate assembly of states general, which met every three years at Dijon, the capital, under the presidency most frequently of the governor of the province. The bishop of Autun was at the head of the clergy; the nobility and gentry had a leader of their own election; and the corresponding place in the third estate belonged to the mayor of Dijon.

See Derichsweiler's *Geschichte der Burgunden*, 1863; Barante's *Histoire des ducs de Bourgogne*, 10 vols. 1824; and De Laborde's *Les ducs de Bourgogne*, 1871.

BURHÁNPUR, a town of British India in the Nimár district of the Central Provinces, situated on the north bank of the River Tapti, in 21° 81′ N. lat. and 76° 20′ E. long., at a distance of 280 miles N.E. of Bombay, and 2 miles from the Great Indian Peninsula Railway station of Lálbágh. It was founded in 1400 A.D. by a Mahometan prince of the Farukhí dynasty of Khandesh, whose successors held it for 200 years, when the Farukhí kingdom was annexed to the empire of Akbar. It formed the chief seat of the Government of the Deccan provinces of the Mughul empire till Sháh Jahán removed the capital to Aurangábád, in 1635. Burhánpur was plundered in 1685 by the Marhattás, and repeated battles were fought in its neighbourhood in the struggle betweeen that race and the Musalmáns for the supremacy of India. In 1739 the Mahometans finally yielded to the demand of the Marhattás for a fourth of the revenue, and in 1760 the Nizám of the Deccan ceded Burhánpur to the Peshwá, who in 1778 transferred it to Sindhiá. In the Marhattá war the army under General Wellesley, afterwards the duke of Wellington, took Burhánpur (1803), but the treaty of the following year restored it to Sindhiá. It remained a portion of Sindhiá's dominions till 1860–61, when, in consequence of certain territorial arrangements, the town and surrounding estates were ceded to the British Government. Under the Mughuls the city covered an area of about 5 square miles, and was about 10½ miles in circumference. In the "Ain-i-Akbarí" it is described as a "large city, with many gardens, inhabited by all nations, and abounding with handicraftsmen." Sir Thomas Roe, who visited it in 1614, found that the houses in the town were "only mud cottages, except the prince's house, the chan's, and some few others." In 1865–66 the city contained 8000 houses, with a population of 34,137, which had decreased to 29,303 in 1872. Burhánpur is celebrated for its muslins, flowered silks, and brocades, which, according to Tavernier, who visited it in 1668, were exported in great quantities to Persia, Egypt, Turkey, Russia, and Poland. The gold and silver wires used in the manufacture of these fabrics are drawn with considerable care and skill; and in order to secure the purity of the metals employed for their composition, the wire-drawing under the native rule was done under Government inspection. The town of Burhánpur and its manufactures have

long been on the decline. The buildings of interest in the town are a palace, built by Akbar, called the Lál Kilá or the Red Fort, and the Jumá Masjid built by Aurungzebe. A considerable number of Borás, a class of commercial Mahometans, reside here. Municipal income of the town in 1872, £3514, 10s.; expenditure, £2321, 12s.

BURIAL AND BURIAL ACTS. The practice of burying in churches or churchyards is said to have been connected with the custom of praying for the dead, and it would appear that the earlier practice was burying in the church itself. "In England, about the year 750, spaces of ground adjoining the churches were carefully enclosed and solemnly consecrated and appropriated to the burial of those who had been entitled to attend divine service in those churches, and who now became entitled to render back into those places their remnants to earth, the common mother of mankind, without payment for the ground which they were to occupy, or for the pious offices which solemnized the act of interment" (Lord Stowell). The right to burial in the parish churchyard is far from being merely an ecclesiastical privilege, but at the same time it is intimately bound up with the laws of the Church Establishment. It is a common law right, controlled in many points by the provisions of the law ecclesiastical. This double character is sufficient to explain the controversy which has so long raged round the subject of burials in England. Every man, according to the common law, has a right to be buried in his own churchyard, or, as it is sometimes put, in the churchyard of the parish where he dies. But the churchyard, as well as the church itself, is the freehold of the parson, who can in many respects deal with it as if it were a private estate. A statute of Edward I. (35, st. 2) speaks of the churchyard as the soil of the church, and the trees growing in the churchyard "as amongst the goods of the church, the which laymen have no authority to dispose," and prohibits "the parsons from cutting down such trees unless required for repairs." Notwithstanding the consecration of the church and churchyard, and the fact that they are the parson's freehold, a right of way may be claimed through them by prescription. The right to burial may be subject to the payment of a fee to the incumbent, if such has been the immemorial custom of the parish, but not otherwise. The spirit of the ancient canons regarded such burial fees as of a simoniacal complexion, inasmuch as the consecrated grounds were among the *res sacræ*—a feeling which Lord Stowell says disappeared after the Reformation. No person can be buried in a church without the consent of the incumbent, except when the owner of a manor house prescribes for a burying-place within the church as belonging to the manor house. In the case of Rex *v.* Taylor it was held that an information was grantable against a parson for opposing the burial of a parishioner; but the court would not interpose as to the parson's refusal to read the burial service because he never was baptized—that being matter for the ecclesiastical court. Strangers (or persons not dying in the parish) should not be buried, it appears, without the consent of the parishioners or churchwardens, "whose parochial right of burial is invaded thereby." According to a recent case, a clergyman may be punished for refusing to read the burial service over a person who had ceased to be a parishioner, but was buried in a family vault. While burial is a common-law right, the mode of burial is said to be of ecclesiastical cognizance, and a mandamus to inter a body in an iron coffin was in one case refused. Lord Stowell permitted the use of iron coffins on condition of an increased rate of payment to the parish, observing that the common cemetery is not *res unius ætatis*, the property of one generation now departed, but of the living and of generations yet unborn, and is subject only to temporary appropriation (Gilbert *v.* Buzzard, 2 Consistory Reports, 333). One of the canons of 1603 requires the clergyman under penalty of suspension for three months to bury the corpse without refusal or delay, "unless the party deceased were excommunicated *majori excommunicatione*, for some grievous and notorious crime, and no man able to testify of his repentance." It appears that persons dying in a state of intoxication must be buried with the funeral service of the church. On the other hand no service but that of the Church of England may be used, and no layman or unauthorized person can read or assist in reading a burial service over a dead body in consecrated ground. Nor, it seems, does the church recognize "such an indecency" as burial without service. There are probably many questions as to the common right of burial to which the law has as yet provided no specific answer. In the meantime many attempts have been made to pass a Burials Bill, the main feature of which is the permission to use in churchyards religious services other than that of the Church of England.

The necessity for providing new cemeteries, caused by the natural increase of population, has led to a good deal of legislation, and an Act was passed (10 and 11 Vict. c. 65) to consolidate certain provisions usually contained in Acts authorizing the making of cemeteries. Sec. 23 allows the bishop to consecrate a part of any such cemetery "for the burial of the dead according to the rites of the Established Church." The 15 and 16 Vict. c. 85, for discontinuing burials in the metropolis and opening new burial grounds, was extended to other towns by the 16 and 17 Vict. c. 134. The new burial ground is to be divided into consecrated and unconsecrated portions; and provision is made for building a cemetery chapel for the use of the church, and, if necessary, another for dissenters. By 20 and 21 Vict. c. 81, ground may be consecrated for the burial of poor persons. The same Act allows a burial board to appeal to the archbishop when the ordinary refuses to consecrate a new burial ground, and if after the archbishop confirms the appeal the bishop still refuses to consecrate, the archbishop may licence the grave for interments as if it were consecrated. The 30 and 31 Vict. c. 133 (amended in the following year) provided facilities for cheapening the expense of consecration and for allowing limited owners to convey sites of land for churchyards.

The practice of burying suicides on a public highway, with a stake driven through the body, is prohibited by 4 Geo. IV. c. 52, which requires the coroner to direct their private interment, without religious rites, in the churchyard, within twenty-four hours after the inquest, and between the hours of nine and twelve at night. Bodies may not be removed from burial grounds without licence from a Secretary of State, except when the removal is from one unconsecrated place to another, and is authorized by the ordinary. A coroner may disinter the body in a case of violent death.

In Scotland the obligation of providing and maintaining the churchyard rests on the heritors of the parish. The guardianship of the churchyard belongs to the heritors and also to the kirk-session, either by delegation from the heritors, or in right of its ecclesiastical character. The right of burial appears to be strictly limited to parishioners, although an opinion has been expressed that any person dying in the parish has a right to be buried in the churchyard. The parishioners have no power of management. The presbytery may interfere to compel the heritors to provide due accommodation, but has no further jurisdiction. It is the duty of the heritors to allocate the churchyard. The Scotch law hesitates to attach the ordinary incidents of real property to the churchyard, while English law treats the ground as the parson's freehold. It would be difficult to say who in Scotland is the legal owner of the

soil. Various opinions appear to prevail, *e.g.*, as to grass growing on the surface and minerals found beneath. The difficulty as to religious services does not exist. On the other hand, the religious character of the ground is hostile to many of the legal rights recognized by the English Law.

BURIAL RITES. See FUNERAL.

BURIATS, a Mongolian race, who dwell in the vicinity of the Baikal Lake, for the most part in the government of Irkutsk and the Trans-Baikal territory. They are divided into various tribes or clans, which generally take their names from the locality they frequent. These tribes are subdivided according to kinship. In 1857 the Buriats numbered 190,000, about two-thirds of whom were in the Trans-Baikal territory. They have high cheek-bones, broad and flat noses, and sparse hair on the chin. The men shave their heads like the Chinese, and leave a tail at the top. In summer they dress in silk and cotton gowns, in winter in furs and sheepskins. Their principal occupation is the rearing of cattle; and some of them possess about 500 oxen and nearly 1000 horses. Some tribes, especially the Idinese, the Kudinese, the Alarese, and the Khorinese, also engage in agriculture,—a department of activity which was totally neglected till 1796, when the last-mentioned tribe first turned its attention to it. As early as 1802 the produce of the Irkutsk government was no less than 9800 quarters of grain; and in 1839 the Buriats had 229,500 acres under cultivation. Their soil is generally fertile, and they have an elaborate system of irrigation by canals and trenches. Their only implements are the plough and the harrow. Wheat, rye, spring corn, and oats are their principal crops; and a large quantity of hay is made for their cattle. A good deal of activity is also shown in trapping and fishing. In religion the Buriats are mainly Buddhists; and their head lama (Khambo Lama) lives at the Goose Lake (Gusinoe Ozero). Others are Shamanists, and their most sacred spot is the Shamanic stone at the mouth of the River Angar. A few only, about 9000 or 10,000, are Christians. A knowledge of reading and writing is diffused, especially among the Trans-Baikal Buriats, who possess books of their own, chiefly translated from the Thibetan. Their own language is Mongolian, and presents three distinct dialects, of which the Selengese is nearest to the written form. The Russians became acquainted with the Buriats in the beginning of the 16th century. In 1631 there was built in their territory, for the purpose of bringing them into subjection. the Bratski block-house, whence arose the Russian designation of Bratski applied to the Buriats. This building was followed by the Kanski block-house in 1640, the Verkholenski in 1641, the Udinski in 1648, the Balaganski in 1654, and finally in 1661 by Irkutsk itself. The Buriats frequently besieged these posts and attacked the Russians, and in 1661 they even slew the Russian ambassador, Zabolotski; but in the end of the 17th century they were finally subdued. (See Gmelin, *Siberia*; Pallas, *Mongol. Völkersch.*; Castren, *Versuch einer Burätisch. Sprachlehre.*)

BURIDAN, JEAN, a celebrated philosopher who flourished in the 14th century, was born at Bethune in Artois, but in what year is not known. He studied at Paris under William of Occam, and became an ardent nominalist. The legend which represents him as having been involved, when a student, in the terrible drama of the Tour de Nesle has no discoverable historical basis. He long held the office of professor of philosophy in the university of Paris; in 1327 he was its rector; in 1345 he was deputed to defend its interests before Philip of Valois and at Rome. He was alive in 1358, but the year of his death has not been recorded. The tradition that he was forced to flee from France along with other nominalists, and that he settled in Vienna, and there founded the university in 1356, is unsupported by evidence and in contradiction to the fact that the university of Vienna was founded by Frederick II. in 1237. An ordinance of Louis XI., in 1473, directed against the nominalists, prohibited the reading of his works. These works treat of logic, metaphysics, physics, ethics, and politics; theology is deliberately avoided on the ground that it does not rest on reason alone, and does not proceed exclusively by argumentation. In philosophy Buridan acknowledged no other authority than that of reason. He followed Occam in resolutely denying all objective reality to universals. He held that singulars or individuals alone exist, and that universals are mere words. "Genera et species non sunt nisi termini apud animam existentes vel etiam termini vocales aut scripti, qui non dicuntur genera aut species nisi secundum attributionem ad terminos mentales quos designant." Occam had not gone so far. The chief aim of his logic is commonly represented as having been the devising of rules for the easy and rapid discovery of syllogistic middle terms,—the construction of a dialectical *pons asinorum*,—but there is nothing in his writings to warrant this representation. The parts of logic which he has treated with most minuteness and subtility are the doctrines of modal propositions and of modal syllogisms. In commenting on Aristotle's *Nicomachean Ethics* he dealt in a very independent and interesting manner with the question of free will. The conclusions at which he arrived are remarkably similar to those long afterwards reached by John Locke. The only liberty which he ascribes to the soul is a certain power of suspending the deliberative process and determining the direction of the intellect. Otherwise the will is entirely dependent on the view of the mind, the last result of examination. The comparison of the will unable to act between two equally balanced motives to a hungry ass unable to eat between two equal and equidistant bundles of hay is not found in any of his works, and may have been invented by his opponents to ridicule his determinism. His works are—*Summula de dialectica*, 1487; *Compendium logicæ*, 1489; *Quæstiones in viii. libros physicorum*, &c., 1516; *In Aristotelis Metaphysica*, 1518; *Quæstiones in x. libros ethicorum Aristotelis*, 1489; *Quæstiones in viii. libros politicorum Aristotelis*, 1500. There may be consulted regarding him, besides the general histories of philosophy, Bayle's *Dictionary*, art. "Buridan"; Prantl's *Geschichte der Logik*, bk. iv. 14–38; and Stöckl's *Geschichte der Philosophie des Mittelalters*, Bd. ii. 1023–1028. (R. F.)

BURKE, EDMUND, one of the greatest names in the history of political literature. There have been many more important statesmen, for he was never tried in a position of supreme responsibility. There have been many more effective orators, for lack of imaginative suppleness prevented him from penetrating to the inner mind of his hearers; defects in delivery weakened the intrinsic persuasiveness of his reasoning; and he had not that commanding authority of character and personality which has so often been the secret of triumphant eloquence. There have been many subtler, more original, and more systematic thinkers about the conditions of the social union. But no one that ever lived used the general ideas of the thinker more successfully to judge the particular problems of the statesman. No one has ever come so close to the details of practical politics, and at the same time remembered that these can only be understood and only dealt with by the aid of the broad conceptions of political philosophy. And what is more than all for perpetuity of fame, he was one of the great masters of the high and difficult art of elaborate composition.

A certain doubtfulness hangs over the circumstances of Burke's life previous to the opening of his public career.

The very date of his birth is variously stated, and has given rise to sharper controversy than the small importance of the discrepancies can deserve. The most probable opinion is that he was born at Dublin on the 12th of January 1729, new style. Of his family we know little more than that his father was a Protestant attorney, practising in Dublin, and that his mother was a Catholic, a member of the family of Nagle. He had at least one sister, from whom are descended the only existing representatives of Burke's family; and he had at least two brothers, Garret Burke and Richard Burke, the one older and the other younger than Edmund. The sister, afterwards Mrs French, was brought up and remained throughout life in the religious faith of her mother; Edmund and his brothers followed that of their father. In 1741 the three brothers were sent to school at Ballitore in the county of Kildare. This school was kept by Abraham Shackleton, an Englishman, and a member of the Society of Friends. He appears to have been an excellent teacher and a good and pious man. Burke always looked back on his own connection with the school at Ballitore as among the most fortunate circumstances of his life. Between himself and a son of his instructor there sprang up a close and affectionate friendship, and, unlike so many of the exquisite attachments of youth, this was not choked by the dust of life, nor parted by divergence of pursuit. Richard Shackleton was endowed with a grave, pure, and tranquil nature, constant and austere, yet not without those gentle elements that often redeem the drier qualities of his religious persuasion. When Burke had become one of the most famous men in Europe, no visitor to his house was more welcome than the friend with whom long years before he had tried poetic flights, and exchanged all the sanguine confidences of boyhood. And we are touched to think of the simple-minded guest secretly praying, in the solitude of his room in the fine house at Beaconsfield, that the way of his anxious and overburdened host might be guided by a divine hand.

In 1743 Burke became a student in that famous institution at Dublin which numbers among its sons so many of the shining names of the 18th century in literature, politics, and law. Oliver Goldsmith was at Trinity College at the same time as Burke. But the serious pupil of Abraham Shackleton would not be likely to see much of the wild and squalid sizar. Henry Flood, who was two years younger than Burke, had gone to complete his education at Oxford. Burke, like Goldsmith, achieved no academic distinction. His character was never at any time of the academic cast. The minor accuracies, the limitation of range, the treading and re-treading of the same small patch of ground, the concentration of interest in success before a board of examiners, were all uncongenial to a nature of exuberant intellectual curiosity and of strenuous and self-reliant originality. His knowledge of Greek and Latin was never thorough, nor had he any turn for critical niceties. He could quote Homer and Pindar, and he had read Aristotle. Like others who have gone through the conventional course of instruction, he kept a place in his memory for the various charms of Virgil and Horace, of Tacitus and Ovid; but the master whose page by night and by day he turned with devout hand, was the copious, energetic, flexible, diversified, and brilliant genius of the declamations for Archias the poet and for Milo, against Catiline and against Antony, the author of the disputations at Tusculum and the orations against Verres. Cicero was ever to him the mightiest of the ancient names.* In our own literature Milton seems to have been more familiar to him than Shakespeare, and Spenser was perhaps more of a favourite with him than either.

It is too often the case to be a mere accident that men who become eminent for wide compass of understanding and penetrating comprehension, are in their adolescence unsettled and desultory. Of this Burke is a signal illustration. He left Trinity in 1748, with no great stock of well-ordered knowledge. He neither derived the benefits nor suffered the drawbacks of systematic intellectual discipline. It would seem that in most cases of vigorous and massive faculty, the highest powers are only thoroughly awakened and concentrated by some stimulus that awakens personal and independent activity. Not the advantages of acquisition, but the necessity of production, are with such men the effectual incentive to the exercise of their fullest capacity.

Burke, after taking his degree at Dublin, went in the year 1750 to London to keep terms at the Temple. The ten years that followed were passed in obscure industry. We know hardly any of the details of this period in his life with satisfactory accuracy or on decisive authority. In that respect at least unlike Cicero, Burke was always extremely reserved about his private affairs. It shows a gratuitous meanness of spirit to explain this reserve by supposing that there was something discreditable or sinister to conceal. All that we know of Burke exhibits him as inspired by a resolute pride, a certain stateliness and imperious elevation of mind. Such a character, while free from any weak shame about the shabby necessities of early struggles, yet is naturally unwilling to make them prominent in after life. There is nothing dishonourable in such an inclination. "I was not swaddled and rocked and dandled into a legislator," wrote Burke when very near the end of his days: "*Nitor in adversum* is the motto for a man like me. At every step of my progress in life (for in every step I was traversed and opposed), and at every turnpike I met, I was obliged to show my passport. Otherwise no rank, no toleration even, for me."

All sorts of whispers have been circulated by idle or malicious gossip about Burke's first manhood. He is said to have been one of the too numerous lovers of his fascinating countrywoman, Margaret Woffington. It is hinted that he made a mysterious visit to the American colonies. He was for years accused of having gone over to the Church of Rome, and afterwards recanting. There is not a tittle of positive evidence for these or any of the other statements to Burke's discredit. The common story that he was a candidate for Adam Smith's chair of moral philosophy at Glasgow, when Hume was rejected in favour of an obscure nobody (1751), can be shown to be wholly false. Like a great many other youths with an eminent destiny before them, Burke conceived a strong distaste for the profession of the law. His father, who was an attorney of substance, had a distaste still stronger for so vagrant a profession as letters were in that day. He withdrew the annual allowance, and Burke was launched on the slippery career of the literary and political adventurer. In fairer words, he set to work to win for himself by indefatigable industry and capability in the public interest that position of power or pre-eminence which his detractors acquired either by accident of birth and connections, or else by the vile arts of political intrigue. He began at the bottom of the ladder, mixing with the Bohemian society that haunted the Temple, practising oratory in the free and easy debating societies of Covent Garden and the Strand, and writing for the booksellers.

In 1756 he made his first mark by a satire upon Bolingbroke, entitled *A Vindication of Natural Society*. It purported to be a posthumous work from the pen of Bolingbroke, and to present a view of the miseries and evils arising to mankind from every species of artificial society. The imitation of the fine style of that magnificent writer but bad patriot is admirable. As a satire the piece

is a failure, for the simple reason that the substance of it might well pass for a perfectly true, no less than a very eloquent, statement of social blunders and calamities. Such acute critics as Chesterfield and Warburton thought the performance serious. Rousseau, whose famous discourse on the evils of civilization had appeared six years before, would have read Burke's ironical vindication of natural society without a suspicion of its irony. There have indeed been found persons who insist that the *Vindication* was a really serious expression of the writer's own opinions. This is absolutely incredible, for various reasons. Burke felt now, as he did thirty years later, that civil institutions cannot wisely or safely be measured by the tests of pure reason. His sagacity discerned that the rationalism by which Bolingbroke and the deistic school believed themselves to have overthrown revealed religion, was equally calculated to undermine the structure of political government. This was precisely the actual course on which speculation was entering in France at that moment. His *Vindication* is meant to be a reduction to an absurdity. The rising revolutionary school in France, if they had read it, would have taken it for a demonstration of the theorem to be proved. The only interest of the piece for us lies in the proof which it furnishes, that at the opening of his life Burke had the same scornful antipathy to political rationalism, which flamed out in such overwhelming passion at its close.

In the same year (1756) appeared the *Philosophical Inquiry into the Origin of our Ideas on the Sublime and Beautiful*, a crude and narrow performance in many respects, yet marked by an independent use of the writer's mind, and not without fertile suggestion. It attracted the attention of the rising æsthetic school in Germany. Lessing set about the translation and annotation of it, and Moses Mendelssohn borrowed from Burke's speculation at least one of the most fruitful and important ideas of his own influential theories on the sentiments. In England the *Inquiry* had considerable vogue, but it has left no permanent trace in the development of æsthetic thought in this country.

Burke's literary industry in town was relieved by frequent excursions to the western parts of England, in company with William Burke. There was a lasting intimacy between the two namesakes, and they seem to have been involved together in some important passages of their lives; but we have Edmund Burke's authority for believing that they were probably not kinsmen. The seclusion of these rural sojourns, originally dictated by delicate health, was as wholesome to the mind as to the body. Few men, if any, have ever acquired a settled mental habit of surveying human affairs broadly, of watching the play of passion, interest, circumstance, in all its comprehensiveness, and of applying the instruments of general conceptions and wide principles to its interpretation with respectable constancy, unless they have at some early period of their manhood resolved the greater problems of society in independence and isolation. By 1756 the cast of Burke's opinions was decisively fixed, and they underwent no radical change.

He began a series of *Hints on the Drama*. He wrote a portion of an *Abridgment of the History of England*, and brought it down as far as the reign of John. It included, as was natural enough in a warm admirer of Montesquieu, a fragment on law, of which he justly said that it ought to be the leading science in every well-ordered commonwealth. Burke's early interest in America was shown by an *Account of the European Settlements* on that continent. Such works were evidently a sign that his mind was turning away from abstract speculation to the great political and economic fields, and to the more visible conditions of social stability and the growth of nations. This interest in the concrete phenomena of society inspired him with the idea of the *Annual Register* (1759), which he designed to present a broad grouping of the chief movements of each year. The execution was as excellent as the conception, and if we reflect that it was begun in the midst of that momentous war which raised England to her climax of territorial greatness in East and West, we may easily realize how the task of describing these portentous and far-reaching events would be likely to strengthen Burke's habits of wide and laborious observation, as well as to give him firmness and confidence in the exercise of his own judgment. Dodsley gave him £100 for each annual volume, and the sum was welcome enough, for towards the end of 1756 Burke had married. His wife was the daughter of a Dr Nugent, a physician at Bath. She is always spoken of by his friends as a mild, reasonable, and obliging person, whose amiability and gentle sense did much to soothe the too nervous and excitable temperament of her husband. She had been brought up, there is good reason to believe, as a Catholic, and she was probably a member of that communion at the time of her marriage. Dr Nugent eventually took up his residence with his son-in-law in London, and became a popular member of that famous group of men of letters and artists, whom Boswell has made so familiar and so dear to all later generations. Burke, however, had no intention of being dependent. His consciousness of his own powers animated him with a most justifiable ambition, if ever there was one, to play a part in the conduct of national affairs. Friends shared this ambition on his behalf; one of these was Lord Charlemont. He introduced Burke to William Gerard Hamilton (1759), now only remembered by a nickname derived from the circumstance of his having made a single brilliant speech in the House of Commons, which was followed by years of almost unbroken silence. Hamilton was by no means devoid of sense and acuteness, but in character he was one of the most despicable men then alive. There is not a word too many nor too strong in the description of him by one of Burke's friends, as "a sullen, vain, proud, selfish, cankered-hearted, envious reptile." The reptile's connection, however, was for a time of considerable use to Burke. When he was made Irish Secretary, Burke accompanied him to Dublin, and there learnt Oxenstiern's eternal lesson, that awaits all who penetrate behind the scenes of government, *quam parva sapientia mundus regitur*.

The penal laws against the Catholics, the iniquitous restrictions on Irish trade and industry, the selfish factiousness of the Parliament, the jobbery and corruption of administration, the absenteeism of the landlords, and all the other too familiar elements of that mischievous and fatal system, were then in full force. As was shown afterwards, they made an impresssion upon Burke that was never effaced. So much iniquity and so much disorder may well have struck deep on one whose two chief political sentiments were a passion for order and a passion for justice. He may have anticipated with something of remorse the reflection of a modern historian, that the absenteeism of her landlords has been less of a curse to Ireland than the absenteeism of her men of genius. At least he was never an absentee in heart. He always took the interest of an ardent patriot in his unfortunate country; and, as we shall see, made more than one weighty sacrifice on behalf of the principles which he deemed to be bound up with her welfare.

When Hamilton retired from his post, Burke accompanied him back to London, with a pension of £300 a year on the Irish Establishment. This modest allowance he hardly enjoyed for more than a single year. His patron having discovered the value of so laborious and powerful a subaltern.

wished to bind Burke permanently to his service. Burke declined to sell himself into final bondage of this kind. When Hamilton continued to press his odious pretensions they quarrelled (1765), and Burke threw up his pension. He soon received a more important piece of preferment than any which he could ever have procured through Hamilton.

The accession of George III. to the throne in 1760 had been followed by the disgrace of Pitt, the dismissal of Newcastle, and the rise of Bute. These events marked the resolution of the court to change the political system which had been created by the Revolution of 1688. That system placed the government of the country in the hands of a territorial oligarchy, composed of a few families of large possessions, fairly enlightened principles, and shrewd political sense. It had been preserved by the existence of a Pretender. The two first kings of the House of Hanover could only keep the crown on their own heads by conciliating the Revolution families and accepting Revolution principles. By 1760 all peril to the dynasty was at an end. George III., or those about him, insisted on substituting for the aristocratic division of political power a substantial concentration of it in the hands of the sovereign. The ministers were no longer to be the members of a great party, acting together in pursuance of a common policy accepted by them all as a united body; they were to become nominees of the court, each holding himself answerable not to his colleagues but to the king, separately, individually, and by department. George III. had before his eyes the government of his cousin the great Frederick; but not every one can bend the bow of Ulysses, and, apart from difference of personal capacity and historic tradition, he forgot that a territorial and commercial aristocracy cannot be dealt with in the spirit of the barrack and the drill-ground. But he made the attempt, and resistance to that attempt supplies the key-note to the first twenty-five years of Burke's political life.

Along with the change in system went high-handed and absolutist tendencies in policy. The first stage of the new experiment was very short. Bute, in a panic at the storm of unpopularity that menaced him, resigned in 1763. George Grenville and the less enlightened section of the Whigs took his place. They proceeded to tax the American colonists, to interpose vexatiously against their trade, to threaten the liberty of the subject at home by general warrants, and to stifle the liberty of public discussion by prosecutions of the press. Their arbitrary methods disgusted the nation, and the personal arrogance of the ministers at last disgusted the king. The system received a temporary check. Grenville fell, and the king was forced to deliver himself into the hands of the orthodox section of the Whigs. The Marquis of Rockingham (July 10, 1765) became prime minister, and he was induced to make Burke his private secretary. Before Burke had begun his duties, an incident occurred which illustrates the character of the two men. The old duke of Newcastle, probably desiring a post for some nominee of his own, conveyed to the ear of the new minister various absurd rumours prejudicial to Burke,—that he was an Irish papist, that his real name was O'Bourke, that he had been a Jesuit, that he was an emissary from St Omer's. Lord Rockingham repeated these tales to Burke, who of course denied them with indignation. His chief declared himself satisfied, but Burke, from a feeling that the indispensable confidence between them was impaired, at once expressed a strong desire to resign his post. Lord Rockingham prevailed upon him to reconsider his resolve, and from that day until Lord Rockingham's death in 1782, their relations were those of the closest friendship and confidence.

The first Rockingham administration only lasted a year and a few days, ending in July 1766. The uprightness and good sense of its leaders did not compensate for the weakness of their political connections. They were unable to stand against the coldness of the king, against the hostility of the powerful and selfish faction of Bedford Whigs, and, above all, against the towering predominance of William Pitt. That Pitt did not join them is one of the many fatal miscarriages of history, as it is one of the many serious reproaches to be made against that extraordinary man's chequered and uneven course. An alliance between Pitt and the Rockingham party was the surest guarantee of a wise and liberal policy towards the colonies. He went further than they did, in holding, like Lord Camden, the doctrine that taxation went with representation, and that therefore Parliament had no right to tax the unrepresented colonists. The ministry asserted, what no competent jurist would now think of denying, that Parliament is sovereign; but they went heartily with Pitt in pronouncing the exercise of the right of taxation in the case of the American colonists to be thoroughly impolitic and inexpedient. No practical difference, therefore, existed upon the important question of the hour. But Pitt's prodigious egoism, stimulated by the mischievous counsels of men of the stamp of Lord Shelburne, prevented the fusion of the only two sections of the Whig party that were at once able, enlightened, and disinterested enough to carry on the government efficiently, to check the arbitrary temper of the king, and to command the confidence of the nation. Such an opportunity did not return.

The ministerial policy towards the colonies was defended by Burke with splendid and unanswerable eloquence. He had been returned to the House of Commons for the pocket borough of Wendover, and his first speech (January 27, 1766) was felt to be the rising of a new light. For the space of a quarter of a century, from this time down to 1790, Burke was one of the chief guides and inspirers of a revived Whig party. The "age of small factions" was now succeeded by an age of great principles, and selfish ties of mere families and persons were transformed into a union resting on common conviction and patriotic aims. It was Burke who did more than any one else to give to the Opposition, under the first half of the reign of George III., this stamp of elevation and grandeur. Before leaving office the Rockingham Government repealed the Stamp Act; confirmed the personal liberty of the subject by forcing on the House of Commons one resolution against general warrants, and another against the seizure of papers; and relieved private houses from the intrusion of officers of excise, by repealing the cider tax. Nothing so good was done in an English parliament for nearly twenty years to come. George Grenville, whom the Rockinghams had displaced, and who was bitterly incensed at their formal reversal of his policy, printed a pamphlet to demonstrate his own wisdom and statesmanship. Burke replied in his *Observations on a late Publication on the Present State of the Nation* (1769), in which he showed for the first time that he had not only as much knowledge of commerce and finance, and as firm a hand, in dealing with figures as Grenville himself, but also a broad, general, and luminous way of conceiving and treating politics, in which neither then nor since has he had any rival among English publicists.

It is one of the perplexing points in Burke's private history to know how he lived during these long years of parliamentary opposition. It is certainly not altogether mere impertinence to ask of a public man how he gets what he lives upon, for independence of spirit, which is so hard to the man who lays his head on the debtor's pillow, is the prime virtue in such men. Probity in money is assuredly one of the keys to character, though we must be very careful in ascertaining and proportioning all the circumstances. Now, in 1769, Burke bought an estate at Beaconsfield, in

the county of Buckingham. It was about 600 acres in extent, was worth some £500 a year, and cost £22,000. People have been asking ever since how the penniless man of letters was able to raise so large a sum in the first instance, and how he was able to keep up a respectable establishment afterwards. The suspicions of those who are never sorry to disparage the great have been of various kinds. Burke was a gambler, they hint, in Indian stock, like his kinsmen Richard and William, and like Lord Verney, his political patron at Wendover. Perhaps, again, his activity on behalf of Indian princes, like the Raja of Tanjore, was not disinterested and did not go unrewarded. The answer to all these calumnious inuendoes is to be found in documents and title-deeds of decisive authority, and is simple enough. It is, in short, this. Burke inherited a small property from his elder brother, which he realized. Lord Rockingham advanced him a certain sum (£6000). The remainder, amounting to no less than two-thirds of the purchase-money, was raised on mortgage, and was never paid off during Burke's life. The rest of the story is equally simple, but more painful. Burke made some sort of income out of his 600 acres; he was for a short time agent for New York, with a salary of £700; he continued to work at the *Annual Register* down to 1788. But, when all is told, he never made as much as he spent; and in spite of considerable assistance from Lord Rockingham, amounting it is sometimes said to as much as £30,000, Burke, like the younger Pitt, got every year deeper into debt. Pitt's debts were the result of a wasteful indifference to his private affairs. Burke, on the contrary, was assiduous and orderly, and had none of the vices of profusion. But he had that quality which Aristotle places high among the virtues,—the noble mean of Magnificence, standing midway between the two extremes of vulgar ostentation and narrow pettiness. He was indifferent to luxury, and sought to make life, not commodious nor soft, but high and dignified in a refined way. He loved art, filled his house with statues and pictures, and extended a generous patronage to the painters. He was a collector of books, and, as Crabbe and less conspicuous men discovered, a helpful friend to their writers. Guests were ever welcome at his board; the opulence of his mind and the fervid copiousness of his talk naturally made the guests of such a man very numerous. *Non invideo equidem, miror magis*, was Johnson's good-natured remark, when he was taken over his friend's fine house and pleasant gardens. Johnson was of a very different type. There was something in this external dignity which went with Burke's imperious spirit, his spacious imagination, his turn for all things stately and imposing. We may say, if we please, that Johnson had the far truer and loftier dignity of the two; but we have to take such men as Burke with the defects that belong to their qualities. And there was no corruption in Burke's outlay. When the Pitt administration was formed in 1766, he might have had office, and Lord Rockingham wished him to accept it, but he honourably took his fate with the party. He may have spent £3000 a year, where he would have been more prudent to spend only £2000. But nobody was wronged; his creditors were all paid in time, and his hands were at least clean of traffic in reversions, clerkships, tellerships, and all the rest of the rich sinecures which it was thought no shame in those days for the aristocracy of the land and the robe to wrangle for, and gorge themselves upon, with the fierce voracity of famishing wolves. The most we can say is that Burke, like Pitt, was too deeply absorbed in beneficent service in the affairs of his country, to have for his own affairs the solicitude that would have been prudent.

In the midst of intense political preoccupations, Burke always found time to keep up his intimacy with the brilliant group of his earlier friends. He was one of the commanding figures at the Club at the Turk's Head, with Reynolds and Garrick, Goldsmith and Johnson. The old sage who held that the first Whig was the Devil, was yet compelled to forgive Burke's politics for the sake of his magnificent gifts. "I would not talk to him of the Rockingham party," he used to say, "but I love his knowledge, his genius, his diffusion and affluence of conversation." And everybody knows Johnson's vivid account of him: "Burke, Sir, is such a man that if you met him for the first time in the street, where you were stopped by a drove of oxen, and you and he stepped aside to take shelter but for five minutes, he'd talk to you in such a manner that when you parted you would say, 'This is an extraordinary man.'" They all grieved that public business should draw to party what was meant for mankind. They deplored that the nice and difficult test of answering Berkeley had not been undertaken, as was once intended, by Burke, and sighed to think what an admirable display of subtlety and brilliance such a contention would have afforded them, had not politics "turned him from active philosophy aside." There was no jealousy in this. They did not grudge Burke being the first man in the House of Commons, for they admitted that he would have been the first man anywhere.

With all his hatred for the book-man in politics, Burke owed much of his own distinction to that generous richness and breadth of judgment which had been ripened in him by literature and his practice in it. Like some other men in our history, he showed that books are a better preparation for statesmanship than early training in the subordinate posts and among the permanent officials of a public department. There is no copiousness of literary reference in his work, such as over-abounded in our civil and ecclesiastical publicists of the 17th century. Nor can we truly say that there is much, though there is certainly some, of that tact which literature is alleged to confer on those who approach it in a just spirit and with the true gift. The influence of literature on Burke lay partly in the direction of emancipation from the mechanical formulæ of practical politics; partly, in the association which it engendered, in a powerful understanding like his, between politics and the moral forces of the world, and between political maxims and the old and great sentences of morals; partly in drawing him, even when resting his case on prudence and expediency, to appeal to the widest and highest sympathies; partly, and more than all, in opening his thoughts to the many conditions, possibilities, and "varieties of untried being," in human character and situation, and so giving an incomparable flexibility to his methods of political approach.

This flexibility is not to be found in his manner of composition. That derives its immense power from other sources; from passion, intensity, imagination, size, truth, cogency of logical reason. Those who insist on charm, on winningness in style, on subtle harmonies and fine exquisiteness of suggestion, are disappointed in Burke: they even find him stiff and over-coloured. And there are blemishes of this kind. His banter is nearly always ungainly, his wit blunt, as Johnson said, and often unseasonable. As is usual with a man who has not true humour, Burke is also without true pathos. The thought of wrong or misery moved him less to pity for the victim than to anger against the cause. Again, there are some gratuitous and unredeemed vulgarities; some images that make us shudder. But only a literary fop can be detained by specks like these.

The varieties of Burke's literary or rhetorical method are very striking. It is almost incredible that the superb imaginative amplification of the description of Hyder Ali's descent upon the Carnatic should be from the same pen as

the grave, simple, unadorned *Address to the King* (1777), where each sentence falls on the ear with the accent of some golden-tongued oracle of the wise gods. His stride is the stride of a giant, from the sentimental beauty of the picture of Marie Antoinette at Versailles, or the red horror of the tale of Debi Sing in Rungpore, to the learning, positiveness, and cool judicial mastery of the *Report on the Lords' Journals* (1794), which Philip Francis, no mean judge, declared on the whole to be the "most eminent and extraordinary" of all his productions. But even in the coolest and dryest of his pieces, there is the mark of greatness, of grasp, of comprehension. In all its varieties Burke's style is noble, earnest, deep-flowing, because his sentiment was lofty and fervid, and went with sincerity and ardent disciplined travail of judgment. He had the style of his subjects; the amplitude, the weightiness, the laboriousness, the sense, the high flight, the grandeur, proper to a man dealing with imperial themes, with the fortunes of great societies, with the sacredness of law, the freedom of nations, the justice of rulers. Burke will always be read with delight and edification, because in the midst of discussions on the local and the accidental, he scatters apophthegms that take us into the regions of lasting wisdom. In the midst of the torrent of his most strenuous and passionate deliverances, he suddenly rises aloof from his immediate subject, and in all tranquillity reminds us of some permanent relation of things, some enduring truth of human life or human society. We do not hear the organ tones of Milton, for faith and freedom had other notes in the 18th century. There is none of the complacent and wise-browed sagacity of Bacon, for Burke's were days of personal strife and fire and civil division. We are not exhilarated by the cheerfulness, the polish, the fine manners of Bolingbroke, for Burke had an anxious conscience and was earnest and intent that the good should triumph. And yet Burke is among the greatest of those who have wrought marvels in the prose of our English tongue.

Not all the transactions in which Burke was a combatant could furnish an imperial theme. We need scarcely tell over again the story of Wilkes and the Middlesex election. The Rockingham ministry had been succeeded by a composite Government, of which it was intended that Pitt, now made Lord Chatham and Privy Seal, should be the real chief. Chatham's health and mind fell into disorder almost immediately after the ministry had been formed. The duke of Grafton was its nominal head, but party ties had been broken, the political connections of the ministers were dissolved, and, in truth, the king was now at last a king indeed, who not only reigned but governed. The revival of high doctrines of prerogative in the Crown was accompanied by a revival of high doctrines of privilege in the House of Commons, and the ministry was so smitten with weakness and confusion as to be unable to resist the current of arbitrary policy, and not many of them were even willing to resist it. The unconstitutional prosecution of Wilkes was followed by the fatal recourse to new plans for raising taxes in the American colonies. These two points made the rallying ground of the new Whig opposition. Burke helped to smooth matters for a practical union between the Rockingham party and the powerful triumvirate, composed of Chatham, whose understanding had recovered from its late disorder, and of his brothers-in-law, Lord Temple and George Grenville. He was active in urging petitions from the freeholders of the counties, protesting against the unconstitutional invasion of the right of election. And he added a durable masterpiece to our political literature in a pamphlet which he called *Thoughts on the Cause of the Present Discontents* (1770). The immediate object of this excellent piece was to hold up the court scheme of weak, divided, and dependent administrations in the light of its real purpose and design; to describe the distempers which had been engendered in parliament by the growth of royal influence and the faction of the king's friends; to show that the newly-formed Whig party had combined for truly public ends, and was no mere family knot like the Grenvilles and the Bedfords; and, finally, to press for the hearty concurrence both of public men and of the nation at large in combining against "a faction ruling by the private instructions of a court against the general sense of the people." The pamphlet was disliked by Chatham on the one hand, on no reasonable grounds that we can discover; it was denounced by the extreme popular party of the Bill of Rights, on the other hand, for its moderation and conservatism. In truth, there is as strong a vein of conservative feeling in the pamphlet of 1770 as in the more resplendent pamphlet of 1790. "Our constitution," he said, "stands on a nice equipoise, with steep precipices and deep waters upon all sides of it. In removing it from a dangerous leaning towards one side, there may be a risk of oversetting it on the other. Every project of a material change in a government so complicated as ours is a matter full of difficulties; in which a considerate man will not be too ready to decide, a prudent man too ready to undertake, or an honest man too ready to promise." Neither now nor ever had Burke any other real conception of a polity for England than government by the territorial aristocracy in the interests of the nation at large, and especially in the interests of commerce, to the vital importance of which in our economy he was always keenly and wisely alive. The policy of George III., and the support which it found among men who were weary of Whig factions, disturbed this scheme, and therefore Burke denounced both the court policy and the court party with all his heart and all his strength.

Eloquence and good sense, however, were impotent in the face of such forces as were at this time arrayed against a Government at once strong and liberal. The court was confident that a union between Chatham and the Rockinghams was impossible. The union was in fact hindered by the waywardness and the absurd pretences of Chatham, and the want of force in Lord Rockingham. In the nation at large, the late violent ferment had been followed by as remarkable a deadness and vapidity, and Burke himself had to admit a year or two later that any remarkable robbery at Hounslow Heath would make more conversation than all the disturbances of America. The duke of Grafton went out, and Lord North became the head of a Government, which lasted twelve years (1770–1782), and brought about more than all the disasters that Burke had foretold as the inevitable issue of the royal policy. For the first six years of this lamentable period Burke was actively employed in stimulating, informing, and guiding the patrician chiefs of his party. "Indeed, Burke," said the duke of Richmond, "you have more merit than any man in keeping us together." They were well meaning and patriotic men but it was not always easy to get them to prefer politics to fox-hunting. When he reached his lodgings at night after a day in the city or a skirmish in the House of Commons, Burke used to find a note from the duke of Richmond or the marquis of Rockingham, praying him to draw a protest to be entered on the Journals of the Lords, and in fact he drew all the principal protests of his party between 1767 and 1782. The accession of Charles James Fox to the Whig party, which took place at this time, and was so important an event in its history, was mainly due to the teaching and influence of Burke. In the House of Commons his industry was almost excessive. He was taxed with speaking too often, and with being too forward. And he was mortified by a more serious charge than murmurs about superfluity of zeal. Men said and said again that he was Junius. His very proper unwillingness to stoop to

deny an accusation, that would have been so disgraceful if it had been true, made ill-natured and silly people the more convinced that it was not wholly false. And the preposterous charge has never wholly died out. But whatever the London world may have thought of him, Burke's energy and devotion of character impressed the better minds in the country. In 1774 he received the great distinction of being chosen as one of its representatives by Bristol, then the second town in the kingdom.

In the events which ended in the emancipation of the American colonies from the monarchy, Burke's political genius shone with an effulgence that was worthy of the great affairs over which it shed so magnificent an illumination. His speeches are almost the one monument of the struggle on which a lover of English greatness can look back with pride and a sense of worthiness, such as a churchman feels when he reads Bossuet, or an Anglican when he turns over the pages of Taylor or of Hooker. Burke's attitude in these high transactions is really more impressive than Chatham's, because he was far less theatrical than Chatham; and while he was no less nobly passionate for freedom and justice, in his passion was fused the most strenuous political argumentation and sterling reason of state On the other hand he was wholly free from that quality which he ascribed to Lord George Sackville, a man "apt to take a sort of undecided, equivocal, narrow ground, that evades the substantial merits of the question, and puts the whole upon some temporary, local, accidental, or personal consideration." He rose to the full height of that great argument. Burke here and everywhere else displayed the rare art of filling his subject with generalities, and yet never intruding common-places. No publicist who deals as largely in general propositions has ever been as free from truisms; no one has ever treated great themes with so much elevation, and yet been so wholly secured against the pitfalls of emptiness and the vague. And it is instructive to compare the foundation of all his pleas for the colonists with that on which they erected their own theoretic declaration of independence. The American leaders were impregnated with the metaphysical ideas of rights which had come to them from the rising revolutionary school in France. Burke no more adopted the doctrines of Jefferson in 1776 than he adopted the doctrines of Robespierre in 1793. He says nothing about men being born free and equal, and on the other hand he never denies the position of the court and the country at large, that the home legislature, being sovereign, had the right to tax the colonies. What he does say is that the exercise of such a right was not practicable; that if it were practicable, it was inexpedient; and that, even if this had not been inexpedient, yet, after the colonies had taken to arms, to crush their resistance by military force would not be more disastrous to them than it would be unfortunate for the ancient liberties of Great Britain. Into abstract discussion he would not enter. "Show the thing you contend for to be reason; show it to be common sense; show it to be the means of attaining some useful end." "The question with me is not whether you have a right to render your people miserable, but whether it is not your interest to make them happy." There is no difference in social spirit and doctrine between his protests against the maxims of the English common people as to the colonists and his protests against the maxims of the French common people as to the court and the nobles; and it is impossible to find a single principle either asserted or implied in the speeches on the American revolution which was afterwards repudiated in the writings on the Revolution in France.

It is one of the signs of Burke's singular and varied eminence that hardly any two people agree precisely which of his works to mark as the masterpiece. Every speech or tract that he composed on a great subject becomes, as we read it, the rival of every other. But the *Speech on Conciliation* (1775) has, perhaps, been more universally admired than any of his other productions, partly because its maxims are of a simpler and less disputable kind than those which adorn the pieces on France, and partly because it is most strongly characterized by that deep ethical quality which is the prime secret of Burke's great style and literary mastery. In this speech, moreover, and in the only less powerful one of the preceding year upon American taxation, as well as in the *Letter to the Sheriffs of Bristol* in 1777, we see the all-important truth conspicuously illustrated that half of his eloquence always comes of the thoroughness with which he gets up his case. No eminent man has ever done more than Burke to justify the definition of genius as the consummation of the faculty of taking pains. Labour incessant and intense, if it was not the source, was at least an inseparable condition of his power. And magnificent rhetorician though he was, his labour was given less to his diction than to the facts; his heart was less in the form than the matter. It is true that his manuscripts were blotted and smeared, and that he made so many alterations in the proofs that the printer found it worth while to have the whole set up in type afresh. But there is no polish in his style, as in that of Junius for example, though there is something a thousand times better than polish. "Why will you not allow yourself to be persuaded," said Francis after reading the *Reflections*, "that polish is material to preservation?" Burke always accepted the rebuke, and flung himself into vindication of the sense substance, and veracity of what he had written. His writing is magnificent, because he knew so much, thought so comprehensively, and felt so strongly.

The succession of failures in America, culminating in Cornwallis's surrender at York Town in October 1781, wearied the nation, and at length the persistent and powerful attacks of the opposition began to tell. "At this time," wrote Burke, in words of manly self-assertion, thirteen years afterwards, "having a momentary lead (1780–2), so aided and so encouraged, and as a feeble instrument in a mighty hand,—I do not say I saved my country,—I am sure I did my country important service. There were few indeed at that time that did not acknowledge it. It was but one voice, that no man in the kingdom better deserved an honourable provision should be made for him." In the spring of 1782 Lord North resigned. It seemed as if the court system which Burke had been denouncing for a dozen years was now finally broken, and as if the party which he had been the chief instrument in instructing, directing, and keeping together must now inevitably possess power for many years to come. Yet in a few months the whole fabric had fallen, and the Whigs were thrown into opposition for the rest of the century. The story cannot be omitted in the most summary account of Burke's life. Lord Rockingham came into office on the fall of North. Burke was rewarded for services beyond price by being made Paymaster of the Forces, with the rank of a Privy Councillor. He had lost his seat for Bristol two years before, in consequence of his courageous advocacy of a measure of tolerance for the Catholics, and his still more courageous exposure of the enormities of the commercial policy of England towards Ireland. He sat during the rest of his parliamentary life (to 1794) for Malton, a pocket borough first of Lord Rockingham's, then of Lord Fitzwilliam's. Burke's first tenure of office was very brief. He had brought forward in 1780 a comprehensive scheme of economical reform, with the design of limiting the resources of jobbery and corruption which the Crown was able to use to strengthen its own sinister influence in Parliament. Administrative reform was, next

to peace with the colonies, the part of the scheme of the new ministry to which the king most warmly objected. It was carried out with greater moderation than had been foreshadowed in opposition. But at any rate Burke's own office was not spared. While Charles Fox's father was at the pay-office (1765–1778) he realized as the interest of the cash balances which he was allowed to retain in his hands, nearly a quarter of a million of money. When Burke came to this post the salary was settled at £4000 a year. He did not enjoy the income long. In July 1782 Lord Rockingham died; Lord Shelburne took his place; Fox, who inherited from his father a belief in Lord Shelburne's duplicity, which his own experience of him as a colleague during the last three months had made stronger, declined to serve under him. Burke, though he had not encouraged Fox to take this step, still with his usual loyalty followed him out of office. This may have been a proper thing to do if their distrust of Shelburne was incurable, but the next step, coalition with Lord North against him, was not only a political blunder, but a shock to party morality, which brought speedy retribution. Either they had been wrong, and violently wrong, for a dozen years, or else Lord North was the guiltiest political instrument since Strafford. Burke attempted to defend the alliance on the ground of the substantial agreement between Fox and North in public aims. The defence is wholly untenable. The Rockingham Whigs were as substantially in agreement on public affairs with the Shelburne Whigs as they were with Lord North. The movement was one of the worst in the history of English party. It served its immediate purpose, however, for Lord Shelburne found himself (February 24, 1783) too weak to carry on the government, and was succeeded by the members of the coalition, with the duke of Portland for prime minister (April 2, 1783). Burke went back to his old post at the pay-office and was soon engaged in framing and drawing the famous India Bill. This was long supposed to be the work of Fox, who was politically responsible for it. We may be sure that neither he nor Burke would have devised any government for India which they did not honestly believe to be for the advantage both of that country and of England. But it cannot be disguised that Burke had thoroughly persuaded himself that it was indispensable in the interests of English freedom to strengthen the party hostile to the court. As we have already said, dread of the peril to the constitution from the new aims of George III. was the main inspiration of Burke's political action in home affairs for the best part of his political life. The India Bill strengthened the anti-court party by transferring the government of India to seven persons named in the Bill, and neither appointed nor removable by the Crown. In other words, the Bill gave the government to a board chosen directly by the House of Commons; and it had the incidental advantage of conferring on the ministerial party patronage valued at £300,000 a year, which would remain for a fixed term of years out of reach of the king. In a word, judging the India Bill from a party point of view, we see that Burke was now completing the aim of his project of economic reform. That measure had weakened the influence of the Crown by limiting its patronage. The measure for India weakened the influence of the Crown by giving a mass of patronage to the party which the king hated. But this was not to be. The India Bill was thrown out by means of a royal intrigue in the Lords, and the ministers were instantly dismissed (December 18, 1783). Young William Pitt, then only in his twenty-fifth year, had been Chancellor of the Exchequer in Lord Shelburne's short ministry, and had refused to enter the coalition Government from an honourable repugnance to join Lord North. He was now made prime minister. The country in the election of the next year ratified the king's judgment against the Portland combination; and the hopes which Burke had cherished for a political life-time were irretrievably ruined.

The six years that followed the great rout of the orthodox Whigs were years of repose for the country, but it was now that Burke engaged in the most laborious and formidable enterprize of his life, the impeachment of Warren Hastings for high crimes and misdemeanours in his government of India. His interest in that country was of old date. It arose partly from the fact of William Burke's residence there, partly from his friendship with Philip Francis, but most of all, we suspect, from the effect which he observed Indian influence to have in demoralizing the House of Commons. "Take my advice for once in your life," Francis wrote to Shee; "lay aside 40,000 rupees for a seat in Parliament: in this country that alone makes all the difference between somebody and nobody." The relations, moreover, between the East India Company and the Government were of the most important kind, and occupied Burke's closest attention from the beginning of the American war down to his own India Bill and that of Pitt and Dundas. In February 1785 he delivered one of the most famous of all his speeches, that on the nabob of Arcot's debts. The real point of this superb declamation was Burke's conviction that ministers supported the claims of the fraudulent creditors in order to secure the corrupt advantages of a sinister parliamentary interest. His proceedings against Hastings had a deeper spring. The story of Hastings's crimes, as Macaulay says, made the blood of Burke boil in his veins. He had a native abhorrence of cruelty, of injustice, of disorder, of oppression, of tyranny, and all these things in all their degrees marked Hastings's course in India. They were, moreover, concentrated in individual cases, which exercised Burke's passionate imagination to its profoundest depths, and raised it to such a glow of fiery intensity as has never been rivalled in our history. For it endured for fourteen years, and was just as burning and as terrible when Hastings was acquitted in 1795, as in the Select Committee of 1781 when Hastings's enormities were first revealed. "If I were to call for a reward," wrote Burke, "it would be for the services in which for fourteen years, without intermission, I showed the most industry and had the least success, I mean in the affairs of India; they are those on which I value myself the most; most for the importance; most for the labour; most for the judgment; most for constancy and perseverance in the pursuit." Sheridan's speech in the House of Commons upon the charge relative to the Begums of Oude probably excelled anything that Burke achieved, as a dazzling performance abounding in the most surprising literary and rhetorical effects. But neither Sheridan nor Fox was capable of that sustained and overflowing indignation at outraged justice and oppressed humanity, that consuming moral fire, which burst forth again and again from the chief manager of the impeachment, with such scorching might as drove even the cool and intrepid Hastings beyond all self-control, and made him cry out with protests and exclamations like a criminal writhing under the scourge. Burke, no doubt, in the course of that unparalleled trial showed some prejudice; made some minor overstatements of his case; used many intemperances; and suffered himself to be provoked into expressions of heat and impatience by the cabals of the defendant and his party, and the intolerable incompetence of the tribunal. It is one of the inscrutable perplexities of human affairs, that in the logic of practical life, in order to reach conclusions that cover enough for truth, we are constantly driven to premises that cover too much, and that in order to secure their right weight to justice and reason, good men are forced to fling the two-edged sword of passion into the same scale. But these excuses were

mere trifles, and well deserve to be forgiven, when we think that though the offender was in form acquitted, yet Burke succeeded in these fourteen years of laborious effort in laying the foundations once for all of a moral, just, philanthropic, and responsible public opinion in England with reference to India, and in doing so performed perhaps the *most* magnificent service that any statesman has ever had it in his power to render to humanity.

Burke's first decisive step against Hastings was a motion for papers in the spring of 1786; the thanks of the House of Commons to the managers of the impeachment were voted in the summer of 1794. But in those eight years some of the most astonishing events in history had changed the political face of Europe. Burke was more than sixty years old when the states-general met at Versailles in the spring of 1789. He had taken a prominent part on the side of freedom in the revolution which stripped England of her empire in the West. He had taken a prominent part on the side of justice, humanity, and order, in dealing with the revolution which had brought to England new empire in the East. The same vehement passion for freedom, justice, humanity, and order was roused in him at a very early stage of the third great revolution in his history—the revolution which overthrew the old monarchy in France. From the first Burke looked on the events of 1789 with doubt and misgiving. He had been in France in 1773, where he had not only the famous vision of Marie Antoinette at Versailles, "glittering like the morning star, full of life, and splendour, and joy," but had also supped and discussed with some of the destroyers, the encyclopædists, "the sophisters, economists, and calculators." His first speech on his return to England was a warning (March 17, 1773) that the props of good government were beginning to fail under the systematic attacks of unbelievers, and that principles were being propagated that would not leave to civil society any stability. The apprehension never died out in his mind; and when he knew that the principles and abstractions, the un-English dialect and destructive dialectic, of his former acquaintances were predominant in the National Assembly, his suspicion that the movement would end in disastrous miscarriage waxed into certainty.

The scene grew still more sinister in his eyes after the march of the mob from Paris to Versailles in October, and the violent transport of the king and queen from Versailles to Paris. The same hatred of lawlessness and violence which fired him with a divine rage against the Indian malefactors was aroused by the violence and lawlessness of the Parisian insurgents. The same disgust for abstractions and naked doctrines of right that had stirred him against the pretensions of the British Parliament in 1774 and 1776, was revived in as lively a degree by political conceptions which he judged to be identical in the French Assembly of 1789. And this anger and disgust were exasperated by the dread with which certain proceedings in England had inspired him, that the aims, principles, methods, and language which he so misdoubted or abhorred in France were likely to infect the people of Great Britain.

In November 1790 the town, which had long been eagerly expecting a manifesto from Burke's pen, was electrified by the *Reflections on the Revolution in France, and on the proceedings in certain societies in London relative to that event*. The generous Windham made an entry in his diary of his reception of the new book. "What shall be said," he added, "of the state of things, when it is remembered that the writer is a man decried, persecuted, and proscribed; not being much valued even by his own party, and by half the nation considered as little better than an ingenious madman?" But the writer now ceased to be decried, persecuted, and proscribed, and his book was seized as the expression of that new current of opinion in Europe which the more recent events of the Revolution had slowly set flowing. Its vogue was instant and enormous. Eleven editions were exhausted in little more than a year, and there is probably not much exaggeration in the estimate that 30,000 copies were sold before Burke's death seven years afterwards. George III. was extravagantly delighted; Stanislaus of Poland sent Burke words of thanks and high glorification and a gold medal. Catherine of Russia, the friend of Voltaire and the benefactress of Diderot, sent her congratulations to the man who denounced French philosophers as miscreants and wretches. "One wonders," Romilly said by-and-by, "that Burke is not ashamed at such success." Mackintosh replied to him temperately in the *Vindiciæ Gallicæ*, and Tom Paine replied to him less temperately but far more trenchantly and more shrewdly in the *Rights of Man*. Arthur Young, with whom he had corresponded years before on the mysteries of deep ploughing and fattening hogs, added a cogent polemical chapter to that ever admirable work, in which he showed that he knew as much more than Burke about the old system of France as he knew more than Burke about soils and roots. Philip Francis, to whom he had shown the proof-sheets, had tried to dissuade Burke from publishing his performance. The passage about Marie Antoinette, which has since become a stock piece in books of recitation, seemed to Francis a mere piece of foppery; for was she not a Messalina and a jade? "I know nothing of your story of Messalina," answered Burke; "am I obliged to prove judicially the virtues of all those I shall see suffering every kind of wrong and contumely and risk of life, before I endeavour to interest others in their sufferings? . . . Are not high rank, great splendour of descent, great personal elegance, and outward accomplishments, ingredients of moment in forming the interest we take in the misfortunes of men? . . . I tell you again that the recollection of the manner in which I saw the queen of France in 1774, and the contrast between that brilliancy, splendour, and beauty, with the prostrate homage of a nation to her, and the abominable scene of 1789 which I was describing, *did* draw tears from me and wetted my paper. These tears came again into my eyes almost as often as I looked at the description,—they may again. You do not believe this fact, nor that these are my real feelings; but that the whole is affected, or as you express it, downright foppery. My friend, I tell you it is truth; and that it is true and will be truth when you and I are no more; and will exist as long as men with their natural feelings shall exist" (*Corr.* iii. 139).

Burke's conservatism was, as such a passage as this may illustrate, the result partly of strong imaginative associations clustering round the more imposing symbols of social continuity, partly of a sort of corresponding conviction in his reason that there are certain permanent elements of human nature out of which the European order had risen and which that order satisfied, and of whose immense merits, as of its mighty strength, the revolutionary party in France were most fatally ignorant. When Romilly saw Diderot in 1783, the great encyclopædic chief assured him that submission to kings and belief in God would be at an end all over the world in a very few years. When Condorcet described the Tenth Epoch in the long development of human progress, he was sure not only that fulness of light and perfection of happiness would come to the sons of men, but that they were coming with all speed. Only those who know the incredible rashness of the revolutionary doctrine in the mouths of its most powerful professors at that time; only those who know their absorption in ends and their inconsiderateness about means, can feel how profoundly right Burke was in all this part of his contention. Napoleon, who had begun life as a disciple of Rousseau, confirmed the wisdom of the philosophy of

Burke when he came to make the Concordat That measure was in one sense the outcome of a mere sinister expediency, but that such a measure was expedient at all sufficed to prove that Burke's view of the present possibilities of social change was right, and the view of the Rousseauites and too sanguine Perfectibilitarians wrong. As we have seen, Burke's very first piece, the satire on Bolingbroke, sprang from his conviction that merely rationalistic or destructive criticism, applied to the vast complexities of man in the social union, is either mischievous or futile, and mischievous exactly in proportion as it is not futile.

To discuss Burke's writings on the Revolution would be to write first a volume upon the abstract theory of society, and then a second volume on the history of France. But we may make one or two further remarks. One of the most common charges against Burke was that he allowed his imagination and pity to be touched only by the sorrows of kings and queens, and forgot the thousands of oppressed and famine-stricken toilers of the land. "No tears are shed for nations," cried Francis, whose sympathy for the Revolution was as passionate as Burke's execration of it. "When the provinces are scourged to the bone by a mercenary and merciless military power, and every drop of its blood and substance extorted from it by the edicts of a royal council, the case seems very tolerable to those who are not involved in it. When thousands after thousands are dragooned out of their country for the sake of their religion, or sent to row in the galleys for selling salt against law,—when the liberty of every individual is at the mercy of every prostitute, pimp, or parasite that has access to power or any of its basest substitutes,—my mind, I own, is not at once prepared to be satisfied with gentle palliatives for such disorders" (*Francis to Burke*, November 3, 1790). This is a very terse way of putting a crucial objection to Burke's whole view of French affairs in 1789. His answer was tolerably simple. The Revolution, though it had made an end of the Bastille, did not bring the only real practical liberty, that is to say, the liberty which comes with settled courts of justice, administering settled laws, undisturbed by popular fury, independent of everything but law, and with a clear law for their direction. The people, he contended, were no worse off under the old monarchy than they will be in the long run under assemblies that are bound by the necessity of feeding one part of the community at the grievous charge of other parts, as necessitous as those who are so fed; that are obliged to flatter those who have their lives at their disposal by tolerating acts of doubtful influence on commerce and agriculture, and for the sake of precarious relief to sow the seeds of lasting want; that will be driven to be the instruments of the violence of others from a sense of their own weakness, and, by want of authority to assess equal and proportioned charges upon all, will be compelled to lay a strong hand upon the possessions of a part. As against the moderate section of the Constituent Assembly this was just.

One secret of Burke's views of the Revolution was the contempt which he had conceived for the popular leaders in the earlier stages of the movement. In spite of much excellence of intention, much heroism, much energy, it is hardly to be denied that the leaders whom that movement brought to the surface were almost without exception men of the poorest political capacity. Danton, no doubt, was abler than most of the others, yet the timidity or temerity with which he allowed himself to be vanquished by Robespierre showed that even he was not a man of commanding quality. The spectacle of men so rash, and so incapable of controlling the forces which they seemed to have presumptuously summoned, excited in Burke both indignation and contempt. And the leaders of the Constituent who came first on the stage, and hoped to make a revolution with rose-water, and hardly realized any more than Burke did how rotten was the structure which they had undertaken to build up, almost deserved his contempt, even if, as is certainly true, they did not deserve his indignation. It was only by revolutionary methods, which are in their essence and for a time as arbitrary as despotic methods, that the knot could be cut. Burke's vital error was his inability to see that a root and branch revolution was, under the conditions, inevitable. His cardinal position, from which he deduced so many important conclusions, namely, that the parts and organs of the old constitution of France were sound, and only needed moderate invigoration, is absolutely mistaken and untenable. There was not a single chamber in the old fabric that was not crumbling and tottering. The court was frivolous, vacillating, stone deaf and stone blind; the gentry were amiable, but distinctly bent to the very last on holding to their privileges, and they were wholly devoid both of the political experience that only comes of practical responsibility for public affairs, and of the political sagacity that only comes of political experience. The parliaments or tribunals were nests of faction and of the deepest social incompetence. The very sword of the state broke short in the king's hand. If the king or queen could either have had the political genius of Frederick the Great, or could have had the good fortune to find a minister with that genius, and the good sense and good faith to trust and stand by him against mobs of aristocrats and mobs of democrats; if the army had been sound and the states-general had been convoked at Bourges or Tours instead of at Paris, then the type of French monarchy and French society might have been modernized without convulsion. But none of these conditions existed.

When he dealt with the affairs of India, Burke passed over the circumstances of our acquisition of power in that continent. "There is a sacred veil to be drawn over the beginnings of all government," he said. "The first step to empire is revolution, by which power is conferred; the next is good laws, good order, good institutions, to give that power stability." Exactly on this broad principle of political force, revolution was the first step to the assumption by the people of France of their own government. Granted that the Revolution was inevitable and indispensable, how was the nation to make the best of it? And how were surrounding nations to make the best of it? This was the true point of view. But Burke never placed himself at such a point. He never conceded the postulate, because, though he knew France better than any body in England except Arthur Young, he did not know her condition well enough. "Alas!" he said, "they little know how many a weary step is to be taken before they can form themselves into a mass which has a true, political personality." And how true this was, it will perhaps take more than a century fully to show. But then nations like individual men are often driven to travel over a weary road that has been long prepared for them by the far-reaching errors of their forefathers and it was only by the journey of which he wisely forewarned them, that they could hope to arrive at the goal of which he unwisely despaired for them.

Burke's view of French affairs, however consistent with all his former political conceptions, put an end to more than one of his old political friendships. He had never been popular in the House of Commons, and the vehemence, sometimes amounting to fury, which he had shown in the debates on the India Bill, on the regency, on the impeachment of Hastings, had made him unpopular even among men on his own side. In May 1789—that memorable month of May in which the states-general marched in

impressive array to hear a sermon at the church of Nôtre Dame at Versailles—a vote of censure had actually been passed on him in the House of Commons for a too severe expression used against Hastings. Fox, who led the party, and Sheridan, who led Fox, were the intimates of the Prince of Wales; and Burke would have been as much out of place in that circle of gamblers and profligates as Milton would have been out of place in the court of the Restoration. The prince, as somebody said, was like his father in having closets within cabinets and cupboards within closets. When the debates on the regency were at their height we have Burke's word that he was not admitted to the private counsels of the party. Though Fox and he were on friendly terms in society, yet Burke admits that for a considerable period before 1790 there had been between them "distance, coolness, and want of confidence, if not total alienation on his part." The younger Whigs had begun to press for shorter parliaments, for the ballot, for redistribution of political power. Burke had never looked with any favour on these projects. His experience of the sentiment of the populace in the two greatest concerns of his life,—American affairs and Indian affairs,—had not been likely to prepossess him in favour of the popular voice as the voice of superior political wisdom. He did not absolutely object to some remedy in the state of representation (*Corr.* ii. 387), still he vigorously resisted such proposals as the duke of Richmond's in 1780 for manhood suffrage. The general ground was this:—"The machine itself is well enough to answer any good purpose, provided the materials were sound. But what signifies the arrangement of rottenness?"

Bad as the parliaments of George III. were, they contained their full share of eminent and capable men; and, what is more, their very defects were the exact counterparts of what we now look back upon as the prevailing stupidity in the country. What Burke valued was good government. His *Report on the Causes of the Duration of Mr Hastings's Trial* shows how wise and sound were his views of law reform. His *Thoughts on Scarcity* attest his enlightenment on the cardinal necessities of trade and manufacture, and even furnished arguments to Cobden fifty years afterwards. Parliaments were competent to discuss, and willing to pass, all measures for which the average political intelligence of the country was ripe. Burke did not believe that altered machinery was at that time needed to improve the quality of legislation. If wiser legislation followed the great reform of 1832, Burke would have said this was because the political intelligence of the country had improved.

Though averse at all times to taking up parliamentary reform, he thought all such projects downright crimes in the agitation of 1791–2. This was the view taken by Burke, but it was not the view of Fox, nor of Sheridan, nor of Francis, nor of many others of his party, and difference of opinion here was naturally followed by difference of opinion upon affairs in France. Fox, Grey, Windham, Sheridan, Francis, Lord Fitzwilliam, and most of the other Whig leaders, welcomed the Revolution in France. And so did Pitt, too, for some time. "How much the greatest event it is that ever happened in the world," cried Fox, with the exaggeration of a man ready to dance the carmagnole, "and how much the best!" The dissension between a man who felt so passionately as Burke, and a man who spoke so impulsively as Charles Fox, lay in the very nature of things. Between Sheridan and Burke there was an open breach in the House of Commons upon the Revolution so early as February 1790, and Sheridan's influence with Fox was strong. This divergence of opinion destroyed all the elation that Burke might well have felt at his compliments from kings, his gold medals, his twelve editions. But he was too fiercely in earnest in his horror of Jacobinism to allow mere party associations to guide him. In May 1791 the thundercloud burst, and a public rupture between Burke and Fox took place in the House of Commons.

The scene is famous in our parliamentary annals. The minister had introduced a measure for the division of the province of Canada and for the establishment of a local legislature in each division. Fox in the course of debate went out of his way to laud the Revolution, and to sneer at some of the most effective passages in the *Reflections*. Burke was not present, but he announced his determination to reply. On the day when the Quebec Bill was to come on again, Fox called upon Burke, and the pair walked together from Burke's house in Duke Street down to Westminster. The Quebec Bill was recommitted, and Burke at once rose and soon began to talk his usual language against the Revolution, the rights of man, and Jacobinism whether English and French. There was a call to order. Fox, who was as sharp and intolerant in the House as he was amiable out of it, interposed with some words of contemptuous irony. Pitt, Grey, Lord Sheffield, all plunged into confused and angry debate, as to whether the French Revolution was a good thing, and whether the French Revolution, good or bad, had anything to do with the Quebec Bill. At length Fox, in seconding a motion for confining the debate to its proper subject, burst into the fatal question beyond the subject, taxing Burke with inconsistency, and taunting him with having forgotten that ever-admirable saying of his own about the insurgent colonists, that he did not know how to draw an indictment against a whole nation. Burke replied in tones of firm self-repression; complained of the attack that had been made upon him; reviewed Fox's charges of inconsistency; enumerated the points on which they had disagreed, and remarked that such disagreements had never broken their friendship. But whatever the risk of enmity, and however bitter the loss of friendship, he would never cease from the warning to flee from the French constitution. "But there is no loss of friends," said Fox in an eager under tone. "Yes," cried Burke, "there *is* a loss of friends. I know the penalty of my conduct. I have done my duty at the price of my friend—our friendship is at an end." Fox rose, but was so overcome that for some moments he could not speak. At length, his eyes streaming with tears, and in a broken voice, he deplored the breach of a twenty years' friendship on a political question. Burke was inexorable. To him the political question was so vivid, so real, so intense, as to make all personal sentiment no more than dust in the balance. Burke confronted Jacobinism with the relentlessness of a Jacobin. The rupture was never healed, and Fox and he had no relations with one another henceforth beyond such formal interviews as took place in the manager's box in Westminster Hall in connection with the impeachment.

A few months afterwards Burke published the *Appeal from the New to the Old Whigs*, a grave, calm, and most cogent vindication of the perfect consistency of his criticisms upon the English Revolution of 1688 and upon the French Revolution of 1789 with the doctrines of the great Whigs who conducted and afterwards defended in Anne's reign the transfer of the crown from James to William and Mary. The *Appeal* was justly accepted as a satisfactory performance for the purpose with which it was written. Events, however, were doing more than words could do, to confirm the public opinion of Burke's sagacity and foresight. He had always divined by the instinct of hatred that the French moderates must gradually be swept away by the Jacobins, and now it was all coming true. The humiliation of the king and queen after their capture at Varennes; the compulsory acceptance of the constitution; the plain incompetence of the new Legislative Assembly; the growing violence of the Parisian mob, and the ascendency of the

Jacobins at the Common Hall; the fierce day of the 20th of June (1792), when the mob flooded the Tuileries, and the bloodier day of the 10th of August, when the Swiss guard was massacred and the royal family flung into prison; the murders in the prisons in September; the trial and execution of the king in January (1793); the proscription of the Girondins in June, the execution of the queen in October—if we realize the impression likely to be made upon the sober and homely English imagination by such a heightening of horror by horror, we may easily understand how people came to listen to Burke's voice as the voice of inspiration, and to look on his burning anger as the holy fervour of a prophet of the Lord.

Fox still held to his old opinions as stoutly as he could, and condemned and opposed the war which England had declared against the French republic Burke, who was profoundly incapable of the meanness of letting personal estrangement blind his eyes to what was best for the commonwealth, kept hoping against hope that each new trait of excess in France would at length bring the great Whig leader to a better mind He used to declaim by the hour in the conclaves at Burlington House upon the necessity of securing Fox; upon the strength which his genius would lend to the administration in its task of grappling with the sanguinary giant; upon the impossibility, at least, of doing either with him or without him. Fox's most important political friends who had long wavered, at length, to Burke's great satisfaction, went over to the side of the Government. In July 1794, the duke of Portland, Lord Fitzwilliam, Windham, and Grenville took office under Pitt. Fox was left with a minority which was satirically said not to have been more than enough to fill a hackney coach. "That is a calumny," said one of the party, "we should have filled two." The war was prosecuted with the aid of both the great parliamentary parties of the country, and with the approval of the great bulk of the nation. Perhaps the one man in England who in his heart approved of it less than any other was William Pitt. The difference between Pitt and Burke was nearly as great as that between Burke and Fox. Burke would be content with nothing short of a crusade against France, and war to the death with her rulers. "I cannot persuade myself," he said, "that this war bears any the least resemblance to any that has ever existed in the world. I cannot persuade myself that any examples or any reasonings drawn from other wars and other politics are at all applicable to it" (*Corr.* iv. 219). Pitt, on the other hand, as Lord Russell truly says, treated Robespierre and Carnot as he would have treated any other French rulers, whose ambition was to be resisted, and whose interference in the affairs of other nations was to be checked. And he entered upon the matter in the spirit of a man of business, by sending ships to seize some islands belonging to France in the West Indies, so as to make certain of repayment of the expenses of the war.

In the summer of 1794 Burke was struck to the ground by a blow to his deepest affection in life, and he never recovered from it. His whole soul was wrapped up in his only son, of whose abilities he had the most extravagant estimate and hope. All the evidence goes to show that Richard Burke was one of the most presumptuous and empty-headed of human beings. "He is the most impudent and opiniative fellow I ever knew," said Wolfe Tone. Gilbert Elliott, a very different man, gives the same account. "Burke," he says, describing a dinner party at Lord Fitzwilliam's in 1793, "has now got such a train after him as would sink anybody but himself: his son, who is quite *nauseated* by all mankind; his brother who is liked better than his son, but is rather oppressive with animal spirits and brogue; and his cousin, William Burke, who is just returned unexpectedly from India, as much ruined as when he went years ago, and who is a fresh charge on any prospects of power Burke may ever have. Mrs Burke has in her train Miss French [Burke's niece], the most perfect *She Paddy* that ever was caught. Notwithstanding these disadvantages Burke is in himself a sort of power in the state. It is not too much to say that he is a sort of power in Europe, though totally without any of those means or the smallest share in them which give or maintain power in other men." Burke accepted the position of a power in Europe seriously. Though no man was ever more free from anything like the egoism of the intellectual coxcomb, yet he abounded in that active self-confidence and self-assertion which is natural in men who are conscious of great powers, and strenuous in promoting great causes. In the summer of 1791 he despatched his son to Coblentz to give advice to the royalist exiles, then under the direction of Calonne, and to report to Beaconsfield their disposition and prospects. Richard Burke was received with many compliments, but of course nothing came of his mission, and the only impression that remains with the reader of his prolix story is his tale of the two royal brothers, who afterwards became Louis XVIII. and Charles X., meeting after some parting, and embracing one another with many tears on board a boat in the middle of the Rhine, while some of the courtiers raised a cry of "Long live the king"—the king who had a few weeks before been carried back in triumph to his capital with Mayor Pétion in his coach. When we think of the pass to which things had come in Paris by this time, and of the unappeasable ferment that boiled round the court, there is a certain touch of the ludicrous in the notion of poor Richard Burke writing to Louis XVI. a letter of wise advice how to comport himself.

At the end of the same year, with the approval of his father, he started for Ireland as the adviser of the Catholic Association. He made a wretched emissary, and there was no limit to his arrogance, noisiness, and indiscretion. The Irish agitators were glad to give him two thousand guineas and to send him home. The mission is associated with a more important thing, his father's *Letters to Sir Hercules Langrishe*, advocating the admission of the Irish Catholics to the franchise. This short piece abounds richly in maxims of moral and political prudence. And Burke exhibited considerable courage in writing it; for many of its maxims seem to involve a contradiction, first, to the principles on which he withstood the movement in France, and second, to his attitude upon the subject of parliamentary reform. The contradiction is in fact only superficial. Burke was not the man to fall unawares into a trap of this kind. His defence of Catholic relief, and it had been the conviction of a life-time, was very properly founded on propositions which were true of Ireland, and were true neither of France nor of the quality of parliamentary representation in England. Yet Burke threw such breadth and generality over all he wrote that even these propositions, relative as they were, form a short manual of statesmanship.

At the close of the session of 1794 the impeachment of Hastings had come to an end, and Burke bade farewell to Parliament. Richard Burke was elected in his father's place at Malton. The king was bent on making the champion of the old order of Europe a peer. His title was to be Lord Beaconsfield, and it was designed to annex to the title an income for three lives. The patent was being made ready, when all was arrested by the sudden death of the son who was to Burke more than life. The old man's grief was agonizing and inconsolable. "The storm has gone over me," he wrote in words which are well known, but which can hardly be repeated too often for any who have an ear for the cadences of noble and pathetic speech,—"The storm has gone over me, and I lie like one of those old oaks which the late hurricane has scattered about me.

I am stripped of all my honours; I am torn up by the roots and lie prostrate on the earth. . . . I am alone. I have none to meet my enemies in the gate. . . . I live in an inverted order. They who ought to have succeeded me have gone before me. They who should have been to me as posterity are in the place of ancestors."

A pension of £2500 was all that Burke could now be persuaded to accept. The duke of Bedford and Lord Lauderdale made some remarks in Parliament upon this paltry reward to a man who, in conducting a great trial on the public behalf, had worked harder for nearly ten years than any minister in any cabinet of the reign. But it was not yet safe to kick up heels in face of the dying lion. The vileness of such criticism was punished, as it deserved to be, in the *Letter to a Noble Lord* (1796), in which Burke showed the usual art of all his compositions in shaking aside the insignificances of a subject. He turned mere personal defence and retaliation into an occasion for a lofty enforcement of constitutional principles, and this, too, with a relevancy and pertinence of consummate skilfulness. There was to be one more great effort before the end.

In the spring of 1796 Pitt's constant anxiety for peace had become more earnest than ever. He had found out the instability of the coalition and the power of France. Like the thrifty steward he was, he saw with growing concern the waste of the national resources and the strain upon commerce, with a public debt swollen to what then seemed the desperate sum of £400,000,000. Burke at the notion of negotiation flamed out in the *Letters on a Regicide Peace*, in some respects the most splendid of all his compositions. They glow with passion, and yet with all their rapidity is such steadfastness, the fervour of imagination is so skilfully tempered by close and plausible reasoning, and the whole is wrought with such strength and fire, that we hardly know where else to look either in Burke's own writings or elsewhere for such an exhibition of the rhetorical resources of our language. We cannot wonder that the whole nation was stirred to the very depths, or that they strengthened the aversion of the king, of Windham, and other important personages in the Government, against the plans of Pitt. The prudence of their drift must be settled by external considerations. Those who think that the French were likely to show a moderation and practical reasonableness in success, such as they had never shown in the hour of imminent ruin, will find Burke's judgment full of error and mischief. Those, on the contrary, who think that the nation which was on the very eve of surrendering itself to the Napoleonic absolutism was not in a hopeful humour for peace and the European order, will believe that Burke's protests were as perspicacious as they were powerful, and that anything which chilled the energy of the war was as fatal as he declared it to be.

When the third and most impressive of these astonishing productions came into the hands of the public, the writer was no more. Burke died on the 8th of July 1797. Fox, who with all his faults was never wanting in a fine and generous sensibility, proposed that there should be a public funeral, and that the body should lie among the illustrious dead in Westminster Abbey. Burke, however, had left strict injunctions that his burial should be private; and he was laid in the little church at Beaconsfield. It was the year of Campo Formio. So a black whirl and torment of rapine, violence, and fraud was encircling the Western World, as a life went out which, notwithstanding some eccentricities and some aberrations, had made great tides in human destiny very luminous. (J. MO.)

BURKE, Robert O'Hara (1821–1861), one of the great explorers of the continent of Australia, was born in 1821 at St Clerans in Galway, Ireland. He left the Belgian college where he had been educated to enter the military service of Austria, but in 1848 returned to Ireland, and obtained a post in the mounted police. He next went to Australia, and served for some time as police-inspector, first in Melbourne and then in the district of Beechworth, till the outbreak of the Crimean War induced him to return to Europe to take part in the campaign. Peace was restored, however, before he arrived, and he accordingly went back to Australia and resumed his connection with the police force. In 1860 he was appointed one of the leaders of a Government exploring expedition, and in this capacity had the honour of being one of the first Europeans to traverse the continent from south to north. A short account of the enterprise—so brilliantly successful in its achievements and so disastrous in its termination—is given in the article Australia, vol. iii. p. 106; and fuller details will be found in the *Journal of the Royal Geographical Society* for 1862. The remains of the explorer were interred by Howitt's relief party in 28° 20′ S. lat. and 141° E. long.

BURLAMAQUI, Jean Jacques (1694–1748), a celebrated writer on natural law, was born at Geneva on the 24th June 1694. He received a careful education, and while passing through his university course devoted himself with such success to the study of ethics and law of nature, that at the age of twenty-five he was designated honorary professor. Before taking possession of his chair he travelled through France and England, and made the acquaintance of the most eminent writers of the period. On his return he began his lectures, and soon gained a wide reputation, from the simplicity of his style and the precision of his views. He continued to lecture for fifteen years, when he was compelled to resign from ill-health. His fellow-citizens at once elected him a member of the council of state, and he gained as high a reputation for his practical sagacity as he had for his theoretical knowledge. He died at Geneva on the 3d April 1748. His works were *Principes du Droit Naturel*, 1747, and *Principes du Droit Politique*, 1751. These have passed through many editions, and were very extensively used as text-books. The most convenient collected edition is that by Dupin, in 5 vols., 1820. Burlamaqui's style is simple and clear, and his arrangement of the material good. His fundamental principle may be described as rational utilitarianism, and it in many ways resembles that of Cumberland.

BURLINGTON, a city and port of entry of the United States, capital of Chittenden county, in Vermont, 38 miles N.W. of Montpelier, in 44° 27′ N. lat., and 73° 10′ W. long. It has a fine situation on the eastern shore of Lake Champlain, and is laid out with great regularity around a central square. Its principal buildings are the Vermont University (which occupies the summit of the slope on which the city is built), the Vermont Episcopal Institute, the court-houses, a jail, a custom-house, and a marine-hospital. The university was founded in 1791, and was endowed by the State with 29,000 acres of land,—to which in 1865 were added 150,000 acres of national grant by the incorporation of the agricultural college. There is a medical school attached. Burlington carries on an extensive trade in lumber, and has the most important share in the shipping traffic of the lake. Its harbour is defended by a breakwater, and a lighthouse was erected at the mouth of the bay in 1862. To the north of the Onion River, but united to Burlington by a bridge, lies the flourishing village of Winooski, with factories and mills. The history of Burlington only dates from 1783; its first church from 1795, and its incorporation as a city from 1864. Population in 1870, 14,387.

BURLINGTON, a city and port of entry of the United States in Burlington county, New Jersey, 18 miles N.E. of Philadelphia, on the Delaware, in 40° 5′ N. lat. and 73°

10′ W. long. It is well built, has an abundant supply of water, and forms a favourite summer resort for the inhabitants of Philadelphia. Its educational institutions are of considerable importance, and comprise an Episcopal college, founded in 1846; St Mary's Hall, also under Episcopalian management; two large boarding schools; and a number of public schools, which are well endowed. There is also a town-hall and a valuable library. Though it has greatly declined with the rise of Philadelphia, Burlington still maintains a respectable shipping trade; in 1871 it had 131 vessels with a registered tonnage of 12,525. The first settlement of the city dates from 1667, and was principally due to a number of Quakers. New Beverly, as the place was originally called, grew rapidly in importance, and was the seat of the Government of New Jersey till 1790. It had a large trade with the West Indies, and was raised to the rank of a bishopric, Queen Anne endowing the church with an extensive estate. Population in 1870, 5817.

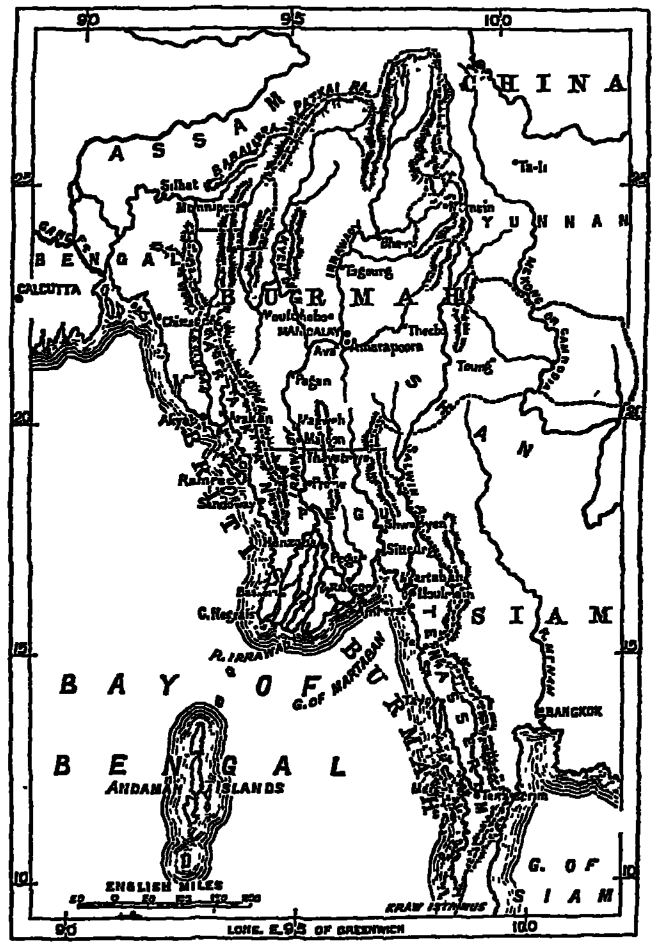
BURLINGTON, a city of the United States, the capital of the county of Des Moines in Iowa, on the right bank of the Mississippi, 207 miles by rail from Chicago. It occupies a natural amphitheatre formed by the limestone bluffs which slope backward from the river. Among the educational institutions the chief place is held by the Business College, founded in 1865, and the Baptist University, which dates from 1854. There are about eight public schools, fifteen churches, and a public library. The commercial activity of the city is very great, and is gradually increasing. Its industrial establishments comprise flour-mills, pork-packing warehouses, foundries, breweries, and soapworks; and the neighbourhood furnishes an abundant supply of coal, building stone, and lime. The city is also the centre of a considerable railway system. Laid out in 1834, it ranked for several years (1837–40) as the capital of Iowa. Population in 1860, 6706; in 1870, 14,933.

BURMAH. The Burman empire, or Independent Burmah, is situated in the S.E. of Asia, in the region beyond the mountains which form the eastern frontier of Bengal. It was formerly of very considerable extent, but its limits have been greatly contracted by British conquest. On the W. where it is conterminous with the British territories in India, the Burman empire is bounded by the province of Arakán, surrendered to the British in 1826, the petty states of Tipperah and Munnepore, and the province of Assam, from which it is separated by lofty ridges of mountains; on the S. by the British province of Pegu, acquired in 1853; on the N. by Assam and Tibet; and on the E. by China and the Shan states. Its limits extend from 19° 30′ to 28° 15′ N. lat., and from 93° 2′ to 100° 40′ E. long., comprising a territory measuring 540 miles in length from north to south, and 420 in breadth, with an area of 190,520 English square miles.

That portion of Asia in which the Burman empire is situated slopes from the central mountains towards the south; and the Burmese territory is watered by four great streams, namely, the Irawadi and the Kyen-dwen, which unite their courses at 21° 50′ N. lat., the Sittang or Pounloung, and the Salwin. The first two rivers have their sources somewhere in the northern chain of mountains in the interior, one head stream of the Irawadi probably coming from Tibet; the Salwin further to the east in Tibet; and the Sittang, which is the smallest of the four, in the hills to the S.E. of Mandalay: they all run in a southerly course to the Indian Ocean. The Irawadi and the Salwin are large rivers, which in the lower part of their course overflow the flat country on their banks during the season of the rains, and in the upper force their way through magnificent defiles. The former is navigable a considerable distance above Bhamo; but the latter is practically useless as a means of communication, owing to the frequent obstacles in its channel. The Burmese empire with its present limits contains no maritime districts, and only isolated tracts of alluvial plain; it is in the main an upland territory, bounded at its southern extremity by a frontier line at the distance of about 200 miles from the mouths of the Irawadi, in 19° 30′ N. lat. From this point the country begins to rise, and thence for about 300 miles farther it contains much rolling country intersected by occasional hill ranges; beyond this it is wild and mountainous.

Productions.

Though inferior in point of fertility to the low-lying tracts of British Burmah, the upland country is far from being unproductive. The chief crops are rice (of which the Burmese count 102 different sorts), maize, millet, wheat, various pulses, tobacco, cotton, and indigo. The sugar cane appears to have been long known to the Burmese;



Sketch-Map of Burmah.

but, though the climate and soil are extremely favourable, it is not generally cultivated. A cheap and coarse sugar is obtained from the juice of the Palmyra palm, which abounds in the tract south of the capital. The cocoa and areca palms are not common. The tea-plant, which is indigenous, is cultivated in the hills by some of the mountain tribes at the distance of about five days' journey, and by others in still greater perfection at the distance of about ten days' journey, from the capital. It seems, however, to be another plant, probably the *Elæodendron persicum*, which furnishes the principal ingredient in the hlapét, or pickled tea, that forms one of the favourite condiments of Burmah. Cotton is grown in every part of the kingdom and its dependencies, but chiefly in the dry lands and climate of the upper provinces. Indigo is indigenous, and is universally cultivated, but in a very rude manner; it is still

more rudely manufactured, and is wholly unfit for exportation.

The most common fruits in Burmah are the mango, the orange, the citron, the pine, the custard apple, the jack, the papaya, and the plantain. The yam and the sweet potato are grown, but not extensively; the common potato is unknown. Onions are produced; and capsicum, which, after salt, is the most ordinary condiment used by the Burmese, is cultivated everywhere.

rests. The forests of Burmah abound in fine trees. Among these the teak holds a conspicuous place; some of the finest teak forests were lost to the Burmese, however, with Pegu. Almost every description of timber known in India is produced in the Burmese forests, from which also an abundant supply is obtained of the varnish employed by the Shans and the Burmese in their manufacture of lacquered ware. Sticklac of an excellent quality is obtained in the woods.[1]

inerals. Burmah is rich in minerals, and produces gold, silver, copper, tin, lead, antimony, bismuth, amber, coal, petroleum, nitre, natron, salt, limestone, and marble, the jade or yu of the Chinese, sapphires, and other precious stones. Gold is found in the sands of different rivers, and also towards the Shan territory on the eastern frontier; but the demand is very much greater than the native supply. Silver is got also near the Chinese frontier. The mountainous districts of the Shan territory contain almost all the other metals; but they are not worked, and the copper and tin, which are seen in the capital, are imported from China. Iron is found in several places, and is wrought especially at Poukpa, near a mountain of that name to the eastward of the old capital Pagán, and also at Maedoo, north-west of the capital; but, owing to ignorance and the want of proper methods, about 30 or 40 per cent. of the metal is lost in the process. Large deposits of rich magnetic oxide, as yet untouched, exist in the ridges east of the capital near the banks of the navigable river Myit-Ngé, and the same district contains lime in great abundance and of remarkable whiteness; while statuary marble, equal to the best Italian specimens, is found about 15 miles north of the capital and east of the Irawadi. Mines of amber are wrought, among other places, at Hookhong or Payendwen, near the sources of the Kyen-dwen, and their produce must be abundant if one may judge from the price of the article at the capital. Nitre, natron, and salt are found in various quarters. Sulphur also occurs in some places, as in the district of Silleh-Myo and in the neighbourhood of the petroleum wells; but the quantity is comparatively small, and a supply has to be obtained from China. Coal has been discovered in patches, but not in any quantity worth working. Petroleum, which is used by all ranks among the Burmese for burning in lamps, and also for smearing wood as a preservative against insects, is found near the village of Ye-nang-gyoung, on the banks of the Irawadi. Here are upwards of one hundred pits or wells, with a general depth of from 210 to 240 feet; though some of them are deeper, and reach to the depth of 300 feet. The shaft is of a square form, from 3 to 4 feet across, and lined with horizontal balks. The liquid appears to boil up from the bottom like an abundant spring, and is extracted in buckets, and sent to all quarters of the country. The annual yield is calculated at 11,690 tons. A good deal is now imported into England.[2]

The precious stones which are produced in the Burmese territories are chiefly the sapphire and the ruby. They are found about 60 or 70 miles in a north-east direction from the capital, over an area of about 100 square miles, by sinking pits in the gem beds. The varieties of the sapphire found there are the *blue* or oriental sapphire, the *red* or oriental ruby, the *purple* or oriental amethyst, the *yellow* or oriental topaz, besides different varieties of chrysoberyl and spinelle. The Crown lays claim to the produce of these rivers; and all the stones that exceed the value of £10 are sent to the treasury.[3] No stranger is ever permitted to approach the spots where these precious stones are found. The yu or jade mines are situated in the Mogoung district, about 25 miles south-west of Meinkhoom. During certain seasons no fewer than 1000 men—Shans, Chinese, Panthays, and Kakhyens—are engaged in the excavation of the stone, which is found in the form of rounded boulders, sometimes of considerable size. Each digger pays so much a month for the right of search, and all he finds becomes his own.[4] Momien, in Yunnan, was formerly the chief seat of the manufacture of the jade, and still produces a considerable quantity of small articles.

The country of the Burmese, abounding in forests, affords extensive shelter to wild animals. The elephant and the rhinoceros—both the one-horned (*R. indicus*) and the two-horned (*R. sumatranus*)—are found in the deep forests of the country. The tiger and the leopard are numerous, as well as the wild hog, and several species of deer, such as the Indian roe, the axis, and the barking deer (*Cervus muntjac*). In the Irawadi is found, as far up as Bhamo, a peculiar kind of dolphin. The rivers and lakes abound with fish, from which the inhabitants prepare their favourite condiment of ngapee. A detailed description of several of the species will be found in Day's contributions to the *Proceedings of the Zoological Society*, 1869, 1870. Of birds, the jungle-fowl is common, and is seen in coveys in all the forests of the country; while domestic breeds, often of very large size, are kept in great numbers, not only for the sake of the eggs or the flesh, but also to afford amusement of a barbarous kind. Aquatic birds of various kinds are very numerous, such as geese, darters (*Flotus melanogaster*), scissor-bills (*Rhyncops nigra*), adjutants (*Leptoptilos argala*), pelicans, cormorants, cranes (*Grus antigone*, in Burmese *gyoja*), whimbrels, plovers, and ibises. There are also peacocks, and varieties of pheasants, partridges, and quails.[5] Anim

The domestic animals are the ox, the buffalo, and the horse. Oxen are used for draught in the upper country, and buffaloes in the southern parts. They are of a good description, and, ranging in the luxuriant pastures of the plains, they commonly appear in high order. The buffalo is confined to agricultural labour, and the ox alone is used as a beast of burden or of draught. The Burman horses, which are rarely more than thirteen hands high, are never used but for riding. Elephants are kept for the pleasure of the king, and the taming of those that are newly caught is one of the favourite spectacles of the people. A white elephant (apparently an albino), when found, is greatly prized, and is kept at court as a sacred appendage of royalty. The dog is neglected, and is seen prowling about the streets, a prey to famine and disease. Cats are numerous; and about the capital a few goats and sheep, of a puny race, are kept more for curiosity than for use. A few asses are also seen, which are brought from China. The camel is not known.

The Burmese in person have the Mongoloid characteristics, common to the Indo-Chinese races, the Tibetans, and tribes of the Eastern Himalaya. They may be gene- Inhabitants.

[1] An article on the Burman flora, by S. Kurtz, will be found in the *Journal of the Asiatic Society of Bengal* for 1874.

[2] See Appendix to Yule's *Narrative*.

[3] *Journal As. Soc. of Bengal*, 1833.

[4] The specimens that are most highly prized are of an emerald green; but red and pale pink are also favourite colours.

[5] An important addition to the natural history of the country has just been made by the representatives of the late Mr E. Blyth in the shape of a "Catalogue of the Mammals and Birds of Burmah," published as an extra number of the *Journal of the As. Soc. of Bengal*, 1875.

rally described as of a stout, active, well-proportioned form; of a brown but never of an intensely dark complexion, with black, coarse, lank, and abundant hair, and a little more beard than is possessed by the Siamese. The name they give their own race is Mran-má (as written), generally pronounced Ba-má, and from this the various forms of "Burmah" appear to have been taken. Besides the Burmese proper, there are numerous tribes of Paloungs, Toungthoos, Karens, and others toward the east, many of them in a state of semi-independence; and all round the northern frontier and along the ranges that traverse the upper regions, vast hordes of Kakhyens or Singphos maintain a rough, cateran life, and come down to levy black mail on the more peaceful inhabitants. The Shans constitute a great number of small principalities along the whole eastern border, subject some to Burmah, some to China, some to Siam, and in some cases owning a double allegiance, according to their position. The Shans everywhere profess Buddhism, and have some kind of literature and the traces of culture. To their race the Siamese themselves belong. The Kakhyens are square-faced, strong-jawed, and oblique-eyed. They are still in a low state of civilization, are destitute of letters, and continue in paganism. Their chiefs are supported by offerings in kind,—receiving, for example, a leg of every animal that is killed. One kind of industry—the manufacture of toddy and arrack—is extensively carried on, and the whole population are regular consumers of the produce.[1] Various other tribes, as the Pwons and the Kakoos, are scattered throughout the empire; but they are not of much individual importance. The population of the country has been variously estimated and grossly exaggerated by the ignorance of Europeans, who have raised it to 17,000,000, 19,000,000, and even 33,000,000. Mr Craufurd, on the best data that he could procure, rated the inhabitants at 22 to the square mile, which, under the now contracted limits of the empire, would give a total population of 3,090,000, and Colonel Yule estimated, in 1855, that, within the area between the British frontier and 24° N. lat., it probably did not exceed 1,200,000; while within the whole empire at its widest limits there were not more than 3,000,000. Count Bethlen states, in 1874, that he obtained statistics of the houses in Burmah from a Burmese official, which made the number 700,000, without including those among the Shans to the east of the Salwin; so that if we allow five inhabitants to each we have 3,500,000 for a total population, and if we include the Shans probably 4,000,000.

vern-nt.

The Burmese government is a pure despotism, the king dispensing torture, imprisonment, or death, according to his sovereign discretion. The chief object of government seems to be the personal honour and aggrandizement of the monarch; and the only restraint on the exercise of his prerogative is the fear of an insurrection He is assisted in his administration by a public and a privy council, known respectively as the Hlot-dau and the Byadeit; all questions, before they are submitted to the public advisers of his majesty, are debated in the privy council, which consists generally of four Atwen-woons to whom are attached deputies, secretaries and other officers (Tsaré dau-gyis, "great royal writers;" Than-dau-zens, "receivers of the royal voice"), who carry messages, and report from time to time the proceedings of the council to the king. The Hlot-dau also usually consists of four ministers or Woongyis, and is presided over by the crown-prince (Einshé-men, or lord of the eastern house). The paymaster-general is an officer of high importance; and the other officers of distinction are the king's armour-bearer and the master of the elephants, but the latter have no share in the administration of public affairs. The king may order any of those great officers to be punished at his pleasure; and a minister may, by his order, be seized by the public executioner, and laid at the side of the road for hours under the burning sun with a weight upon his breast; and after undergoing this disgraceful punishment, may continue to discharge his high function as before. The country at large is ruled by provincial governors, and is divided into provinces (or Myos), townships, districts, and villages. The civil, military, judicial, and fiscal administration of the province is vested in the governor, or Myo-woon, who exercises the power of life and death, though in all civil cases an appeal lies from his sentence to the chief council at the capital. In all the townships and villages there are judges with a subordinate jurisdiction. But from a mere detail of the provincial administration and judicial institutions of the Burmese, their extreme inefficiency can scarcely be known. No Burmese officer ever receives a fixed salary. The higher class is paid by an assignment either of land or of the labour and industry of a given portion of the inhabitants, and the inferior magistrates by fees, perquisites, and other emoluments; and hence extortion and bribery prevail amongst all the functionaries of the Burmese Government. Justice is openly exposed for sale; and the exercise of the judicial functions is so lucrative, that the two executive councils have by their encroachments deprived the regular judge of the greater part of his employment.

The Burmese laws are mainly contained in the *Dhammasat*, a code ascribed to Manu, but quite different from the Manu's Code of the Brahmans. It is said to have been introduced into Burmah from Ceylon by Buddaghosha, the traditional apostle of the Indo-Chinese nations.[2] The criminal code is barbarous and severe, and the punishments are shocking to humanity. Gang robbery, desertion from the king's service, robbing of temples, and sedition or treason, are considered the most heinous crimes, and are cruelly punished, the criminal being in some cases embowelled, or thrown to wild beasts. Decapitation is the general mode of execution, but crucifixion and fracture of the limbs are also practised, and women are usually put to death by the stroke of a bludgeon across the throat. For minor offences, fines, whipping, and imprisonments are the punishments adjudged. In important cases torture is applied both to principals and witnesses; and the jailers often torture their prisoners in order to extort money from them. The English and American prisoners during the war of 1824 were frequently tortured, and had to pay fines to the jailer in order to procure milder treatment. Trial by ordeal is sometimes resorted to, as well as other superstitious modes of procedure. The administration of justice, however vexatious and expensive, is far from efficient; and the police is as bad as can possibly be conceived.

Ranks of society

There are no hereditary honours under the Burmese Government. All the public functionaries may be dismissed from their offices, and deprived of their rank at the caprice of the sovereign; while any subject, with the exception of a slave or outcast, may aspire to the first offices in the state, to which, in reality, persons of very mean origin do frequently attain. The great officers of Government hold the first rank after the king and the princes of the blood, and are distinguished by a chain or badge, which is the order of nobility, and of which there are different degrees, distinguished by the number of strings or small chains which compose the ornament. Three of open chain-work mark the lowest rank; three of neatly-twisted wire the next; there are then six, nine, twelve, and finally twenty-four, which the king alone is entitled to wear. But every article possessed

[1] See for details regarding the Shans and Kakhyens Anderson's *Expedition to Eastern Yunan*, ch v. Appendix B contains a list of 200 words in the Shan, Kakhyen, Paloung, and Leesaw languages.

[2] A translation has been made into English by Richardson.

by a Burman for use or ornament—his ear-rings, cap of ceremony, horse-furniture, the material of his drinking-cup, if it be of gold or any other metal, the colour and quality of his umbrella (an article in general use, and one of the principal insignia of rank), whether it be of brown varnished paper, red, green, gilded, or plain white, the royal colour—all indicate the rank of the person; if any of the lower orders usurp the insignia of a higher class, he may be slain with impunity by the first person who meets him; and so exclusive is the aristocratical spirit of the higher orders, that such a usurpation would be sure of punishment.

When a merchant acquires property he is registered by a royal edict under the name of Thuthé or "rich man," which gives him a title to the protection of the court, while it exposes him also to regular extortion. The priesthood form a separate order, who are interdicted from all other employment, and are supported by voluntary contributions. They are distinguished by the yellow colours in their dress, which it would be reckoned sacrilege in any other person to wear. A formal complaint was made, during the conferences with the British previous to the peace, because some of their camp followers were seen dressed in yellow clothes. There is also an order of nuns and priestesses, who make a vow of chastity, but may at any time quit their order.

The free labouring population consist of proprietors or common labourers; and they are all considered the slaves of the king, who may at all times call for their services as soldiers, artizans, or common labourers. Hence a Burman, being the property of the king, can never quit the country without his especial permission, which is only granted for a limited time, and never to women on any pretence. The British and others who had children by Burmese women during a residence in the country experienced the greatest difficulty, even with the aid of heavy douceurs, in taking them along with them. The *Dhammasat* numbers seven classes of slaves, of which the most important are prisoners of war, and those who have mortgaged their services for a debt. The class of outcasts consists of the slaves of the pagodas, the burners of the dead, the jailers and executioners (who are generally condemned criminals), and the lepers and other incurables, who are held in great abhorrence, and treated with singular caprice and cruelty. They are condemned to dwell alone, and in a state of disgrace; and any man who is infected with leprosy, however high his rank, is forced, by continual bribes to the officers of justice, to purchase an exemption from the penalties which attach to him. Prostitutes are also considered as outcasts. The women in Burmah are not shut up as in many other parts of the East, and excluded from the sight of men; on the contrary, they are suffered to appear openly in society, and have free access in their own name to the courts of law, where, if ill-treatment is proved, divorce is readily obtained. In many other respects, however, they are exposed to the most degrading treatment. They are sold for a time to strangers; and the practice is not considered shameful, nor the female in any respect dishonoured. They are seldom unfaithful to their new master; and many of them have proved essentially useful to strangers in the Burmese dominions, being generally of industrious and domestic habits, and not addicted to vice.

Revenue.

The taxes from which the public revenue arises are in general rude and ill-contrived expedients for extortion, and are vexatious to the people at the same time that they are little productive to the state. The most important is the house or family tax, which is said to be assessed by a *Doomsday Book*, compiled by order of Mentaragyi in 1783. The amount varies greatly in different years, and to a remarkable extent in different districts. Next in order is the tax on agriculture, which is also very irregularly imposed. A large part of the cultivated land of the kingdom is assigned to favourites of the court or to public functionaries in lieu of stipends or salaries, or is appropriated to the expenses of public establishments, such as war-boats, elephants, &c.; and this assignment conveys a right to tax the inhabitants according to the discretion of the assignee. The court favourites who receive these grants generally appoint agents to manage their estates; they pay a certain tax or quit-rent to the crown, and their agents extort from the cultivators as much more as they can by every mode of oppression, often by torture. Besides this stated tax, extraordinary contributions are levied by the council of the state directly from the lords and nobles to whom the lands are assigned, who in their turn levy it from the cultivators, and generally make it a pretence for plunder and extortion. Taxes are also laid on fruit-trees, on the sugar palm, on the tobacco-land on the teak forests, on the petroleum springs, on mines of gold and precious stones, on the fishery of ponds, lakes, rivers, and salt-water creeks, on the manufacture of salt, on the eggs of the green turtle, and on esculent swallows' nests. As the consumption of wines, spirits, opium, and other intoxicating drugs is forbidden by law, they cannot, of course, be subject to any tax.

In many of the useful arts the Burmese have not made any great advances, while in others they are possessed of no small amount of proficiency. The architecture of religious edifices erected in the Middle Ages is of striking and effective character, though only of brick. The general style bears evidence of an Indian origin; but numerous local modifications have been introduced. Perhaps the feature of most interest is the use of the pointed arch as well as the flat and the circular, and that at a time long anterior to its employment in India. Modern buildings are chiefly of wood; palaces and monasteries, carved with extraordinary richness of detail, and often gilt all over, present an aspect of barbaric splendour. The dagobas, or solid domes, which form at once the objects and the localities of Buddhist worship, are almost the only brick structures now erected; and these are often gilt all over. In carving the Burmese artisans display unusual skill and inventiveness, and give full scope to the working of a luxuriant and whimsical fancy. As in our mediæval woodwork, sometimes there is often displayed a large amount of satirical and facetious caricature. The application of gilding is carried to an extravagant extent; as much as £40,000 is said to have been expended on this article for a single temple. The finest architectural monuments are to be found in the deserted city of Pagán; and many of the most magnificent are greatly shattered by earthquakes.[1] The number of religious buildings, small and great, throughout the country is enormous; at every turn the traveller finds pagodas or kyoungs (monasteries), or lesser shrines, or zayats (resting-places for travellers founded by the Buddhists in order to acquire religious merit). The ordinary buildings are of a very slight construction, and the architect is prevented from giving them any great height by the whimsical prejudice of the people against any one walking over their heads. The whole process of the cotton manufacture is performed by women, who use a rude but efficient species of loom, and produce an excellent cloth, though they are much inferior in dexterity to the Indian artisans. Silk cloths are manufactured at different places from Chinese silk. The favourite patterns are zigzag longitudinal stripes of different colours, and the brilliance of the contrasts is frequently gorgeous in its results. The dyeing of the yellow robes of the priests is effected by means of the leaves of the jacktree

Arts and manufactures.

[1] For full details the reader ought to consult Captain Yule's chapter on Pagán.

The common, coarse, unglazed earthenware is of an excellent quality; and a better description of pottery is also made. The art of making porcelain, however, is entirely unknown, and this ware is imported from China. Iron ore, as already mentioned, is smelted; but the Burmans cannot manufacture steel, which is brought from Bengal. Bell-founding has been carried to considerable perfection; and the craftsmen take pride in the magnitude of some of their productions. Perhaps the largest specimen is that in the neighbourhood of Amarapura, which measures 16 feet across the lip and weighs about 80 tons. Coarse articles of cutlery, including swords, spears, knives, also muskets and matchlocks, scissors, and carpenters' tools, are manufactured in the capital, and gold and silver ornaments are produced in every considerable place in the country. Embossed work in drinking cups and the like is executed with great richness of effect. North of the capital, and east of the Irawadi, as before stated, is an entire hill of pure white marble, and there are sculptured marble images of Gautama or Buddha. The marble is of the finest quality; and the workmen give it an exquisite polish by means of a paste of pulverized fossil wood. The chief seat of the manufacture of lacquered wares is at Nyoun-goo, near the ancient city of Pagán. Since Burmah was deprived of its harbours and maritime districts, its foreign commerce has been extremely limited. The trade of the country centres chiefly in the capital. The imports are rice, pickled and dried fish, and foreign commodities obtained from Bengal, the Asiatic Archipelago, and Europe. Petroleum, saltpetre, lime, paper, lacquer-ware, cotton and silk fabrics, iron, cutlery, some brass ware, terra japonica, sugar, and tamarinds are given in exchange. One of the most important branches of the trade of the country was formerly that maintained with the Chinese province of Yunnan; but it has been for a considerable period in abeyance owing to the disturbed state of the frontier counties. The principal marts of this trade, which was carried on at annual fairs, were Madé, near the capital, and Bhamo. The Chinese caravan, setting out from the western province of Yunnan at the close of the periodical rains, generally reached Burmah in the beginning of December, after a journey of six weeks over difficult and mountainous roads. The principal fair was held at Bhamo, comparatively few traders arriving at the capital. The articles imported from China were raw silk, wrought copper, orpiment or yellow arsenic from the mines in Yunnan (of a very fine quality, which found its way into Western Asia, and into Europe through Calcutta), quicksilver, vermilion, iron pans, brass-wire, tin, lead, alum, silver, gold and gold-leaf, earthenware, paints, carpets, rhubarb, tea, honey, velvets and other wrought silks, spirits, musk, verdigris, dry fruits, paper, fans, umbrellas, shoes, and wearing apparel. The metals were chiefly produced in the province of Yunnan. The articles sent to China consisted of raw cotton, by far the most considerable article of export; feathers, chiefly of the blue jay, for ornamenting the dresses of ceremony of the Chinese mandarins; esculent swallows' nests, ivory, rhinoceros' and deers' horns; sapphires, used for buttons to the caps of the Chinese officers of rank, jade, and amber, with a small quantity of British woollens. The trade of the northern part of Burmah proper is chiefly carried on at large fairs held in connection with religious festivals. One of the most important articles, in addition to European cloth goods, is salt, for their supply of which all the hill-tribes are dependent on Burmah.[1]

Money. The currency used by the Burmese is of the rudest description. For the smaller payments lead is employed; and for the larger payments silver almost exclusively. This is not coined into pieces of any known weight and fineness; and in every payment of any consequence the metal must be weighed and is generally assayed, for which a premium is paid to the bankers or money-changers of $2\frac{1}{2}$ per cent. besides 1 per cent. which they say is lost in the operation. There are three or four different alloys of silver in common use as money; the best is Bau, which is almost pure; next is Dain, with about 6·4 per cent. of copper; and so on through several grades. An attempt was made by King Mentaragyi to introduce a coinage; but his plans failed because he fixed the current value of his money considerably above the real value of the silver. The high rate of interest for money—which is 25 per cent., and 60 per cent. when no security is given—is another proof of the low state of commerce among the Burmese. The seeds of the *Abrus precatorius* (Khyin Rhwe), a little red and black pea, serve as the smallest weight; they ordinarily weigh about a grain, but vary from one to two. Two of them make a rhwe-kyi, four rhwe-kyis a great pae, four great paes a mat, four mats a kyap, and 100 kyaps a piktha (peissa) or viss, which is equal to 3·6516 lb avoirdupois. The Burmese year is divided into three seasons and twelve months, beginning with what corresponds to our April, and every third year a month is intercalated. Every pakka or half-month consists of 15 days (ret) of 60 narih each. The ret is divided into the nay or period from sunrise to sunset, and the gnyin or period from sunset to sunrise,—the 60 narih being assigned in different proportions to the two periods in each of the twelve months, the first month having 30 in each period, and the second 30 in the daytime and 28 in the night, and so on. The Burmese have borrowed their astronomy and astrology, as well as this division of the day, from the Hindus. They are ignorant of oceanic navigation; and in their voyages to Calcutta, during the fine season, they creep along the coast, never losing sight of it.

The Burmese proper use a monosyllabic language, spoken with distinctive tones, like the Chinese and several other Indo-Chinese tongues. Its vocabulary shows distinct relation to Chinese on one side and to Tibetan on another. In contrast with Siamese it is a very soft and flexible language, and its monosyllabic character is somewhat modified in pronunciation. It has no distinctly sibilant sound, the only letter approximate to "s" having a resemblance rather to the English "th." It is a literary language, and has been under cultivation for perhaps six or seven centuries. It is written with an alphabet of Indian origin, which probably came in with Buddhism; and most of the letters are of a more or less circular form. The Pali remaining the dialect of sacred literature, the Burmese has been almost confined to secular uses. It has developed a poetic diction of such complete individuality that it is unintelligible without special study. Another peculiar dialect, largely mingled with Pali elements, is spoken at court, and also requires separate study, as it substitutes a vocabulary of elaborate artificiality subordinate to the etiquette of the courtiers. The word for "to go," for example, is different according as it is said that the king goes, or the prince goes, or the priest goes. Of the literary forms in which the Burmese express themselves, the favourite one is the drama, which appears under the various forms of masquerades, puppet shows, ballet-opera, and farces, as well as in the more dignified character of the regular tragedy. The moral character of the plays is often of the lowest kind, the utmost licence both of speech and action being allowed on the stage. The scenery is of a very simple and purely suggestive kind, a single branch of a tree standing for a forest, and frequently the filling up of the dialogue is largely left to the ingenuity of the actors, little more than hints of the plot being con-

[1] An interesting survey of the various trade-routes from Burmah to China is given by Mr J. Coryton in the *Jour. of the R. Geogr. Soc.* for 1875.

tained in many of the librettos. The popular interest in the dramatic exhibitions is intense, and, as in Siam, the same piece often drags its slow length along for days together. Specimens of the plots will be found in the appendixes to Yule's *Narrative*, Williams's *Through Burmah*, and Bastian's *Reisen*. The national chronicles, or chronicles of the kings (*Maha-Radza Weng*), go back at least in name to the early centuries of the Christian era, but their historical value is of a very dubious kind. Libraries are common throughout the country, principally in the monasteries. Though a certain kind of paper is manufactured from bamboo pulp, the usual material of the books is the palm leaf, while for ordinary notebook purposes a kind of black tablet, called a *parabeik*, and a steatite pencil are employed. A dictionary of Burmese was published by Judson at Maulmein in 1852; Schleiermacher made the language the object of a remarkable study in his *Influence of Writing upon Language*, 1835; and Bastian has contributed an essay on the literature to the *Zeitschrift der Deutschen Morgenl. Gesellschaft*, 1863, and has also published an interesting sketch of the peculiarities of the language in his *Sprachvergleichende Studien*, Leipsic, 1870.

igion. The Burmese are votaries of Buddha, and the rites, doctrines, and priesthood are in their main features the same as in other countries where Buddhism prevails. Every Burman must, at some period or other of his life, spend some time in a monastery; and it is no uncommon thing for a man to retire for a longer or shorter period from the bustle of life without any intention of permanently adopting the yellow robe which is the distinctive mark of the regular monk. Dr Bastian has supplied a great many interesting details on the religious beliefs and ceremonies of the people, but they are as yet unfortunately scattered through the pages of his *Travels*. Neither Christianity nor Mahometanism has made much progress, though a certain number of Mahometans have existed, especially at the capital, for a long time, and have mosques there. Foreigners enjoy religious toleration, but the Burmese rulers view any attempt to convert the natives to the Christian or any other foreign faith as an interference with their allegiance. An American mission was settled in the country in 1815, under the conduct of Dr Judson before mentioned, who brought to this perilous service zeal and discretion; but it entirely failed of success, not from any bigotry on the part of the natives, but from the opposition of men in power. On the war breaking out with the British the missionaries were imprisoned, and narrowly escaped with their lives, and on their release they retired to prosecute their labours in the British province of Martaban. There are now in the capital representatives of both English and French missionary agencies.

Education throughout the Burman empire is still in the ecclesiastical stage, but the educational statistics compare favourably with those of many portions of Europe. The first book, according to Dr Bastian, which is put into the hands of the boys in the monastery schools is the *Sin-pungyi*, or Great Basket of Learning, in which the meaning of the Burmese letters is explained. After this they learn the injunctious of religion in the *Mengalasut*, and next the prayers of Gautama in the *Pharitgyi*, which is written in Pali, so that their study consists in mechanically committing it to memory. They then proceed to the *Djats* (stories or legends) in which the Burmese words are mingled with Pali expressions and contractions; later on they pass to the study of *Saddo* or grammar, and finally to that of the *Yok* or general cyclopædia. For those who enter the monastic profession there remain the Pali texts. The historical books are then read, as well as the *Pu-és* or dramatic productions. Fluency of speech and great skill in carrying on an argument according to their own system of dialectics are the common possessions of the educated Burmese, and an unshaken conviction in the truth of their religion is almost universal.

It is probable that Burmah is the *Chryse Regio* of Ptolemy, a name parallel in meaning to *Sonaparanta*, the classic Pali title assigned to the country round the capital in Burmese documents. The royal history traces the lineage of the kings to the ancient Buddhist monarchs of India. This no doubt is fabulous, but it is hard to say how early communication with Gangetic India began. From the 11th to the 13th century the old Burman empire was at the height of its power, and to this period belong the splendid remains of architecture at Pagán. The city and the dynasty were destroyed by a Chinese (or rather Mongol) invasion (1284 A.D.) in the reign of Kublai Khan. After that the empire fell to a low ebb, and Central Burmah was often subject to Shan dynasties. In the early part of the 16th century the Burmese princes of Toungoo, in the north-east of Pegu, began to rise to power, and established a dynasty which at one time held possession of Pegu, Ava, and Arakán. They made their capital at Pegu, History.
and to this dynasty belong the gorgeous descriptions of some of the travellers of the 16th century. Their wars exhausted the country, and before the end of the century it was in the greatest decay. A new dynasty arose in Ava, which subdued Pegu, and maintained their supremacy throughout the 17th and during the first forty years of the 18th century. The Peguans or Taleins then revolted, and having taken the capital Ava, and made the king prisoner, reduced the whole country to submission. Alompra, left by the conqueror in charge of the village of Monchaboo, planned the deliverance of his country. He attacked the Peguans at first with small detachments; but when his forces increased, he suddenly advanced, and took possession of the capital in the autumn of 1753. In 1754 the Peguans sent an armament of war-boats against Ava, but they were totally defeated by Alompra; while in the districts of Prome, Donabew, Loonzay, &c., the Burmans revolted, and expelled all the Pegu garrisons in their towns. In 1754 Prome was besieged by the king of Pegu, who was again defeated by Alompra, and the war was transferred from the upper provinces to the mouths of the navigable rivers, and the numerous creeks and canals which intersect the lower country. In 1755 Apporaza, the king of Pegu's brother, was equally unsuccessful, after which the Peguans were driven from Bassein and the adjacent country, and were forced to withdraw to the fortress of Syriam, distant twelve miles from Rangoon. Here they enjoyed a brief repose, Alompra being called away to quell an insurrection of his own subjects, and to repel an invasion of the Siamese; but returning victorious, he laid siege to the fortress of Syriam and took it by surprise. In these wars the French sided with the Peguans, the English with the Burmans. Dupleix, the governor of Pondicherry, had sent two ships to the aid of the former; but the master of the first, was decoyed up the river by Alompra, where he was massacred along with his whole crew. The other escaped to Pondicherry. Alompra was now master of all the navigable rivers; and the Peguans, shut out from foreign aid, were finally subdued. In 1757 the conqueror laid siege to the city of Pegu, which capitulated, on condition that their own king should govern the country, but that he should do homage for his kingdom, and should also surrender his daughter to the victorious monarch. Alompra never contemplated the fulfilment of the condition; and having obtained posesssion of the town, abandoned it to the fury of his soldiers. In the following year the Peguans vainly endeavoured to throw off the yoke. Alompra afterwards reduced the town and district of Tavoy, and finally undertook the conquest of

the Siamese. His army advanced to Mergui and Tenasserim, both which towns were taken; and he was besieging the capital of Siam when he was taken ill. He immediately ordered his army to retreat, in hopes of reaching his capital alive; but he expired on the way, in 1760, in the fiftieth year of his age, after he had reigned eight years. In the previous year he had massacred the English of the establishment of Negrais, whom he suspected of assisting the Peguans. He was succeeded by his oldest son Noungdaugyi, whose reign was disturbed by the rebellion of his brother Tshen-byo-yen or Shembuan, and afterwards by one of his father's generals. He died in little more than three years, leaving one son in his infancy; and on his decease the throne was seized by his brother Tshen-byo-yen. The new king was intent, like his predecessors, on the conquest of the adjacent states, and accordingly made war in 1765 on the Munnipore kingdom, and also on the Siamese, with partial success. In the following year he defeated the Siamese, and, after a long blockade, obtained possession of their capital. But while the Burmans were extending their conquests in this quarter, they were invaded by a Chinese army of 50,000 men from the province of Yunnan. This army was hemmed in by the skill of the Burmans; and, being reduced by the want of provisions, it was afterwards attacked and totally destroyed, with the exception of 2500 men, who were sent in fetters to work in the Burmese capital at their several trades. In the meantime the Siamese revolted, and while the Burman army was marching against them, the Peguan soldiers who had been incorporated in it rose against their companions, and commencing an indiscriminate massacre, pursued the Burman army to the gates of Rangoon, which they besieged, but were unable to capture. In 1774 Tshen-byo-yen was engaged in reducing the marauding tribes. He took the district and fort of Martaban from the revolted Peguans; and in the following year he sailed down the Irawadi with an army of 50,000 men, and, arriving at Rangoon, put to death the aged monarch of Pegu, along with many of his nobles, who had shared with him in the offence of rebellion. He died in 1776, after a reign of twelve years, during which he had extended the Burmese dominions on every side. He was succeeded by his son, a youth of eighteen, called Tsengoomen (Chenguza of Symes), who proved himself a bloodthirsty despot, and was put to death by his uncle, Bhodauphra or Mentaragyi, in 1781, who ascended the vacant throne. In 1783 the new king effected the conquest of Arakán. In the same year he removed his residence from Ava,[1] which, with brief interruptions, had been the capital for four centuries, to the new city of Amarapura, "the City of the Immortals."

The Siamese who had revolted in 1771 were never afterwards subdued by the Burmans; but the latter retained their dominion over the sea-coast as far as Mergui. In the year 1785 they attacked the island of Junkseylon with a fleet of boats and an army, but were ultimately driven back with loss; and a second attempt by the Burman monarch, who in 1786 invaded Siam with an army of 30,000 men, was attended with no better success. In 1793 peace was concluded between these two powers, the Siamese yielding to the Burmans the entire possession of the coast of Tenasserim on the Indian Ocean, and the two important seaports of Mergui and Tavoy.

In 1795 the Burmese were involved in a dispute with the British in India, in consequence of their troops, to the amount of 5000 men, entering the district of Chittagong in pursuit of three robbers who had fled from justice across the frontier. Explanations being made and terms of accommodation offered by General Erskine, the commanding officer, the Burmese commander retired from the British territories, when the fugitives were restored, and all differences for the time amicably arranged.

But it was evident that the gradual extension of the British and Burmese territories would in time bring the two powers into close contact along a more extended line of frontier, and in all probability lead to a war between them. It happened, accordingly, that the Burmese, carrying their arms into Assam and Munnipore, penetrated to the British border near Sylhet, on the N.E. frontier of Bengal, beyond which were the possessions of the chiefs of Cachar, under the protection of the British Government. The Burmese leaders, arrested in their career of conquest, were impatient to measure their strength with their new neighbours. It appears from the evidence of Europeans who resided in Ava, that they were entirely unacquainted with the discipline and resources of the Europeans. They imagined that, like other nations, they would fall before their superior tactics and valour; and their cupidity was inflamed by the prospect of marching to Calcutta and plundering the country. At length their chiefs ventured on the open violation of the British territories. They attacked a party of sepoys within the frontier, and seized and carried off British subjects, while at all points their troops, moving in large bodies, assumed the most menacing positions. In the south encroachments were made upon the British frontier of Chittagong. The island of Shaparee, at the mouth of the Naf river, had been occupied by a small guard of British troops. These were attacked on the 23d September 1823 by the Burmese, and driven from their post with the loss of several lives; and to the repeated demands of the British for redress no answer was returned. Other outrages ensued; and at length, in February 1824, war was declared by the British Government.

Hostilities having commenced, the British rulers in India resolved to carry the war into the enemy's country; an armament, under Commodore Grant and Sir Archibald Campbell, entered the Irawadi River, and anchored off Rangoon on the 10th May 1824. After a feeble resistance this great seaport surrendered, and the troops were landed. The place was entirely deserted by its inhabitants, the provisions were carried off or destroyed, and the invading force took possession of a complete solitude. On the 28th May, Sir A. Campbell ordered an attack on some of the nearest posts, which were all carried after a feeble defence. Another attack was made on the 10th June on the stockades at the village of Kemmendine. Some of these were battered by artillery; and the shot and shells struck such terror into the Burmese that they fled in the utmost precipitation. It soon, however, became apparent that the expedition had been undertaken with very imperfect knowledge of the country, and without adequate provision. The devastation of the country, which was part of the defensive system of the Burmese, was carried out with unrelenting rigour, and the invaders were soon reduced to great difficulties. The health of the men declined, and their ranks were fearfully thinned. The monarch of Ava sent large reinforcements to his dispirited and beaten army; and early in July an attack was commenced on the British line, but proved unsuccessful. On the 8th the British assaulted. The enemy were beaten at all points; and their strongest stockaded works, battered to pieces by a powerful artillery, were in general

[1] The frequent change of capital is quite remarkable in Burmese history. In the earlier periods, it is probable that the chronicles have made it seem more frequent than it is, by running the history of minor contemporaneous kingdoms into that of one great monarchy. But in more recent times the capital has been shifted from Prome to Pagán, from Pagán to Panya, from Panya to Ava, and from Ava to Amarapura; and since the present monarch was visited by the English embassy of 1855, he has caused Amarapura to be abandoned, and has built a new city at Mandalay, which is at present the chief city in the empire.

abandoned. With the exception of an attack by the prince of Sarawadi in the end of August, the enemy allowed the British to remain unmolested during the months of July and August. This interval was employed by Sir A. Campbell in subduing the Burmese provinces of Tavoy and Mergui, and the whole coast of Tenasserim. This was an important conquest, as the country was salubrious and afforded convalescent stations to the sick, who were now so numerous in the British army that there were scarcely 3000 soldiers fit for duty. An expedition was about this time sent against the old Portuguese fort and factory of Syriam, at the mouth of the Pegu River, which was taken; and in October the province of Martaban was reduced under the authority of the British.

The rainy season terminated about the end of October; and the court of Ava, alarmed by the discomfiture of its armies, recalled the veteran legions which were employed in Arakán, under their renowned leader Maha Bandoola, in vain attempts to penetrate the British frontier. Bandoola hastened by forced marches to the defence of his country; and by the end of November an army of 60,000 men had surrounded the British position at Rangoon and Kemmendine, for the defence of which Sir Archibald Campbell had only 5000 efficient troops. The enemy in great force made repeated attacks on Kemmendine without success, and on the 7th December Bandoola was completely routed by Sir A. Campbell. The fugitives retired to a strong position on the river, which they again entrenched; and here they were attacked by the British on the 15th, and driven in complete confusion from the field.

Sir Archibald Campbell now resolved to advance on Prome, about 100 miles higher up the Irawadi River. He moved with his force on the 13th February 1825 in two divisions, one proceeding by land, and the other, under General Cotton, destined for the reduction of Donabew, being embarked on the flotilla. Taking the command of the land force he continued his advance till the 11th March, when intelligence reached him of the failure of the attack upon Donabew. He instantly commenced a retrograde march; on the 27th he effected a junction with General Cotton's force, and on the 2d April carried the entrenchments at Donabew with little resistance, Bandoola having been killed by the explosion of a bomb. The English general entered Prome on the 25th, and remained there during the rainy season. On the 17th September an armistice was concluded for one month. In the course of the summer General Morrison had conquered the province of Arakán; in the north the Burmese were expelled from Assam; and the British had made some progress in Cachar, though their advance was finally impeded by the thick forests and jungle.

The armistice having expired on the 17th October, the army of Ava, amounting to 60,000 men, advanced in three divisions against the British position at Prome, which was defended by 3000 Europeans and 2000 native troops. But the British still triumphed, and after several actions, in which the Burmese were the assailants and were partially successful, Sir A. Campbell, on the 1st December, attacked the different divisions of their army, and successively drove them from all their positions, and dispersed them in every direction. The Burmese retired on Meaday and afterwards on Mellone, along the course of the Irawadi, where they occupied, with 10,000 or 12,000 men, a series of strongly fortified heights and a formidable stockade. On the 26th they sent a flag of truce to the British camp; and a negotiation having commenced, peace was proposed to them on the following conditions:—*1st*, The cession of Arakán, together with the provinces of Mergui, Tavoy, and Yea; *2d*, The renunciation by the Burmese sovereign of all claims upon Assam and the contiguous petty states; *3d*, The Company to be paid a crore of rupees as an indemnification for the expenses of the war; *4th*, Residents from each court to be allowed, with an escort of fifty men; while it was also stipulated that British ships should no longer be obliged to unship their rudders and land their guns as formerly in the Burmese ports. This treaty was agreed to and signed, but the ratification of the king was still wanting; and it was soon apparent that the Burmese had no intention to sign it, but were preparing to renew the contest. On the 19th January, accordingly, Sir A. Campbell attacked and carried the enemy's position at Mellone. Another offer of peace was here made by the Burmese, but it was found to be insincere; and the fugitive army made at the ancient city of Pagán-Myo a final stand in defence of the capital. They were attacked and overthrown on the 9th February 1826; and the invading force being now within four days' march of Ava, Dr Price, an American missionary, who with other Europeans had been thrown into prison when the war commenced, was sent to the British camp with the treaty (known as the Treaty of Yandabo) ratified, the prisoners of war released, and an instalment of 25 lacs of rupees. The war was thus brought to a successful termination, and the British army evacuated the country.

For some years the relations of peace continued undisturbed. Probably the feeling of amity on the part of the Burmese Government was not very strong; but so long as the prince by whom the treaty was concluded continued in power, no attempt was made to depart from its main stipulations. That monarch, Phagyi-dau or Noungdaugyi, however, was obliged in 1837 to yield the throne to a usurper who appeared in the person of his brother, Kounboungmen or Tharawadi. The latter, at an early period, manifested not only that hatred of British connection which was almost universal at the Burmese court, but also the extremest contempt. For several years it had become apparent that the period was approaching when war between the British and the Burmese Governments would again become inevitable. The British resident, Major Burney, who had been appointed in 1830, finding his presence at Ava agreeable neither to the king nor to himself, removed in 1837 to Rangoon, and shortly afterwards retired from the country. Ultimately it became necessary to forego even the pretence of maintaining relations of friendship, and the British functionary at that time, Captain Macleod, was properly withdrawn, in 1840, altogether from a country where his continuance would have been but a mockery. The state of sullen dislike which followed was after a while succeeded by more active evidences of hostility. Acts of violence were committed on British ships and British seamen. Remonstrance was consequently made by the British Government, and its envoys were supported by a small naval force. The officers on whom devolved the duty of representing the wrongs of their fellow-countrymen and demanding redress, proceeded to Rangoon, the governor of which place had been a chief actor in the outrages complained of; but so far were they from meeting with any signs of regret, that they were treated with indignity and contempt, and compelled to retire without accomplishing anything beyond blockading the ports. A series of negotiations followed; nothing was demanded of the Burmese beyond a very moderate compensation for the injuries inflicted on the masters of two British vessels, an apology for the insults offered by the governor of Rangoon to the representatives of the British Government, and the re-establishment of at least the appearance of friendly relations by the reception of a British agent by the Burmese Government. But the obduracy of the king—known as the Pagán-men, who had succeeded his father in 1846—led to the refusal alike of atonement for past wrongs, of any expression of regret for the display of

gratuitous insolence, and of any indication of a desire to maintain friendship for the future. Another Burmese war was the result, the first shot being fired in January 1852. As in the former, though success was varying, the British finally triumphed, and the chief towns in the lower part of the Burmese kingdom fell to them in succession. The city of Pegu, the capital of that portion which, after having been captured, had again passed into the hands of the enemy, was recaptured and retained, and the whole province of Pegu was, by proclamation of the Governor-General, Lord Dalhousie, declared to be annexed to the British dominions on the 20th December 1852. No treaty was obtained or insisted upon,—the British Government being content with the tacit acquiescence of the king of Burmah without such documents; but its resolution was declared, that any active demonstration of hostility by him would be followed by retribution.

About the same time a revolution broke out which resulted in Pagán-men's dethronement. His tyrannical and barbarous conduct had made him obnoxious at home as well as abroad, and indeed many of his actions recall the worst passages of the history of the later Roman emperors. The prince of Mendoon, who had become apprehensive for his own safety, made him prisoner in February 1853, and was himself crowned king of Burmah towards the end of the year. The new monarch, known as Mendoon-men, has shown himself sufficently arrogant in his dealings with the European powers, but has been wise enough to keep free from any approach towards hostility, and, indeed, has latterly displayed a desire to live on peaceful terms with the Indian Government. The loss of Pegu was long a matter of bitter regret, and he absolutely refused to acknowledge it by a formal treaty. In the beginning of 1855 he sent a mission of compliment to Lord Dalhousie, the Governor-General; and in the summer of the same year Major Arthur Phayre, *de facto* governor of the new province of Pegu, was appointed envoy to the Burmese court. He was accompanied by Captain (now Colonel) Henry Yule as secretary, and Mr Oldham as geologist, and his mission added largely to our knowledge of the state of the country; but in its main object of obtaining a treaty it was unsuccessful. It was not till 1862 that the king at length yielded, and his relations with Britain were placed on a definite diplomatic basis. Much interest has been taken of recent years in the restoration of the trade between China and British Burmah by the old routes overland, and various important journeys in elucidation of the problem have been successfully undertaken. In 1863 Dr Clement Williams, at that time resident in the capital, received the king's permission to proceed to Bhamo, and safely accomplished his voyage to the upper defile of the Irawadi beyond that town in the months of January and February. His recall to the capital prevented his further advance.

In 1867 a treaty was signed by which British steamers were permitted to navigate Burmese waters, and the appointment of British agents at Bhamo or other stations for the collection of customs was formally authorized, and in the following year a Government expedition, consisting of Captain Williams as engineer, Dr Anderson as naturalist, and Captain Bowers and Messrs Stewart and Burn as representatives of the commercial interest of Rangoon, was despatched under the leadership of Major Sladen, political resident at Mandalay. The royal steamer *Yaynan-Sekia*, or "The Honesty," was placed by the king at the service of the expedition, and letters of recommendation were furnished to the Burmese officials, but in other respects scant courtesy was shown to the party. Escorted by fifty armed police, the explorers advanced in safety about 135 miles north-east of Bhamo to Momien or Teng-yue-Chow, a principal town of the Mahometan insurgents, known to the Burmese as Panthés; but beyond this it was considered imprudent to proceed on account of the disturbed condition of the country. In 1869 Captain Storer was appointed first British resident at Bhamo; and about the same time the Irawadi Flotilla Company started a monthly steamer service to that town, which has now become almost fortnightly. The king's interest in the commercial development of his country was shown by his erecting and garrisoning a series of guardhouses through the dangerous parts of the Kakhyen hills. In 1874 Lord Salisbury sent another expedition, consisting of Colonel Horace Browne, Mr Ney Elias, and Dr Anderson, with instructions to proceed, if possible, right across the country to Shanghai in China; and to ensure the success of the undertaking, Mr Margary, a gentleman familiar with the Chinese language and customs, was commissioned to start from Shanghai and meet the party at Momien or the neighbourhood. The king's reception of the new mission, which arrived on December 23, 1874, at Mandalay, was favourable in the extreme. On the 15th of January 1875 the explorers reached Bhamo; and two days afterwards Mr Margary arrived from Hankow. After the mission had proceeded to the banks of the Nampoung, a river which joins the Tapeng some distance east of Ponline, they heard rumours of hostile preparations in front; and Mr Margary volunteered to proceed to Manwyne to find the truth of the reports. On receiving from him word that the way was clear, his companions advanced; but on the 23d of February their camp was attacked by the Chinese, and they were ultimately compelled to retreat with the sad knowledge that their gallant pioneer had fallen at Manwyne by the hands of cowardly assassins. The Burmese officials stood nobly by the mission, though the enemy assured them that their quarrel was not with them but with the "white devils." Some fears have been entertained of disagreements between the court of Mandalay and the British authorities, partly in regard to the allegiance of some Karen tribes, and partly in connection with the claim for a right of way for British troops through the Burmese dominions in case of active measures being required to obtain redress from the Chinese Government for the murder of Mr Margary. Happily these fears have been disappointed; the mission of Sir Douglas Forsyth has come to a peaceful if not altogether a successful termination, and a commission has been formed to settle the Karen boundary. While a certain amount of suspicion in regard to British policy still remains in the king's mind, he seems more and more disposed to co-operate with his European allies, and shows himself friendly to the European residents in his capital. His reign has been several times disturbed by internal dissensions, and the general condition of the country can hardly be regarded as one of stability. Personally he is an orthodox and devoted Buddhist, and is largely under the influence of ecclesiastical advisers. In 1874 he was recrowned at Mandalay, in compliance with the requirements of a prophecy, and he attempts to enforce stringent sumptuary laws in accordance with his creed. It is satisfactory to know that while some of his officials are undoubtedly hostile to European interests, the great mass of the people seem genuinely favourable.

See Sangermano, *Burmese Empire*; Captain Hiram Cox, *Journal of a Residence in the Burman Empire*, 1821; Syme's *Embassy to the Kingdom of Ava*, 1800; Snodgrass, *Narrative of the Burmese War*, 1827; Wayland, *Life of Judson*, 1853; Mason, *The Natural Productions of Burma*, Maulmein, 1850; C. T. Winter's *Six Months in British Burmah*, 1858; Yule, *Narrative of the Mission sent by the Gov.-Gen. of India to the Court of Ava in* 1855, 1858; Bastian, *Reisen in Birma in den Jahren* 1861–1862, 1866; Clement Williams, *Through Burmah to Western China, Notes of a Journey in* 1863, 1868; Anderson's *Expedition to E. Yunan viâ Bhamô*, 1871, and *Mandalay and Momein*, 1876; Trant's *Two Years in Ava*; A. R. M'Mahon's *The Karens and the Golden Chersonese*. 1876.

BURMAH, British, the country acquired by the British Indian Government after the two wars with the Burman empire, is situated between 10° and 22° N. lat., and 92° and 100° E. long. It is bounded on the N. by Independent Burmah, on the E. by Siam, on the S. by the Indian Ocean, and on the W. by the Bay of Bengal and the *Chittagong* division of Bengal. The province of British Burmah extends along the eastern shore of the Bay of Bengal, and is geographically divided into four portions,—Arakán, extending from the Náf estuary to Cape Negrais, and consisting of a narrow strip of country between the sea and the high mountain chain called Yoma; the valley of the Irawadi, which, divided from the Sittang valley by the Pegu Yoma range, unites with it in its southern portion; the valley of the Salwin; and Tenasserim, a narrow strip, separated from Siam by a lofty chain of hills running from north to south. For administrative purposes the country is divided into three commissionerships, Arákán, Pegu, and Tenasserim, and into fifteen districts, viz., Akyab, Ramree, Sandoway, Northern Arákán, Rangoon, Bassein, Myanoung, Prome, Thayet-myo, Toungoo, Shwegyen, Amherst, Tavoy, Mergui, and Salwin.

Physical Aspects.—The greater part of the province is covered with hills, forests, estuaries, and river beds. The eastern and southern part is particularly mountainous, thinly populated, and much intersected by streams. In the central part of the province the valley of the Irawadi unites with the valley of the Sittang at its lower end, and forms an extensive plain, stretching from Cape Negrais on the west to Martaban on the east. The more northern of these valleys are rugged and hilly, and are so densely covered with jungle that but little cultivation can be carried on. A chain of mountains called the Yoma range forms the boundary of the Arakán division on the east. It is the continuation of the Pátkoi and Baráil range, which shoots forth from the Himálayas at their north-eastern extremity, runs south, forms the eastern boundary of Assam and Bengal, and turning south-east, gradually diminishes both in breadth and elevation till it ends in the rocky promontory of Cape Negrais. Blue Mountain, one of its peaks, on the northern boundary of the province, is said to rise 8000 feet above the sea-level; but within the province the range nowhere attains a height much above 4000 feet. The same Yoma range forms the western boundary of the Irawadi valley; and the Poung Loung range, rising to a supposed height of 7000 feet, bounds the Sittang valley towards the east The Pegu Yoma range forms the watershed between these two streams. The mountains of Tenasserim rise to a height of 5000 feet, with a breadth varying from 10 to 40 miles; they are covered with pathless jungle, and devoid of human habitations of any kind.

Rivers.—Beginning from the extreme west the following are the principal rivers:—The Náf estuary is on the western boundary. The Mroo River, an arm of the sea, about 40 miles to the eastward, is from 3 to 4 miles broad at its mouth. The Koladan or Arakán River rises near the Blue Mountain in about 23° N. lat., and is navigable for 40 miles from its mouth by vessels of 300 or 400 tons burden. The Talak, Aeng, Sandoway, Toungoop, and Gwa are streams of minor importance. The mouth of the last, however, forms a good port and haven for steamers or vessels of from 9 to 10 feet draught. The Irawadi rises in about 28° N. lat. and 97° 30′ E. long., and flows for upwards of 600 miles before reaching the British possessions, through which it has a course of 240 miles to the sea in a S.S.W. the;tion. As it approaches the coast it divides into numenegot ranches, converting the lower portion of the valley on the et-work of tidal creeks. Its principal branches are togethesein River, Thekkay-thoung, Yuay, Dayaybhyoo, 2*l*, Thaloo, Pyengazaloo. Dalla, Phyapoon, Donyan, Thanaupon teat, and China Buckir rivers. It is navigable for river steamers as far as Bhamo, nearly 400 miles beyond the British frontier. The river when full runs about five miles an hour. The Hleing rises close to Prome, where it is called the Myitmakat stream, and flowing in a southerly direction nearly parallel to the Irawadi, it next takes the name of the Hleing, and finally of the Rangoon River, and falls into the sea a few miles below Rangoon. Its principal tributaries are the Nyoungdon, an offshoot of the Irawadi, and the Pegu and Poozoondoung rivers. It is navigable by vessels of the largest size for some distance above Rangoon, but owing to the Hastings shoal, formed at the junction of the Pegu, the Poozoondoung, and the Rangoon rivers, vessels of more than 6 feet draught cannot ascend beyond the shoal at low tide. The Sittang River rises far north of British territory, which it enters just about Toungoo, and flowing southwards, falls into the Gulf of Martaban, when it widens so rapidly that it is impossible to tell where the river ends and the gulf begins. Its principal tributary is the Shwegyen River. A bore, or tidal wave, sweeps up this river, and its effect is felt as far as Shwegyen town. The Biling River rises in the Poungloung hills, flows southward, and falls into the Gulf of Martaban. The Salwin River rises in Tibet, flows south through the Shan states, and falls into the sea at Moulmein. The Attaran rises in the chain of hills which forms the boundary between the kingdom of Siam and British Burmah, and flows in a south-westerly direction through dense teak forests and an almost uninhabited country. The Gyne has numerous villages on its banks, and is navigable for 180 miles by country boats. The Tenasserim River falls into the sea by two mouths, the northern of which is navigable for large ships.

There is only one canal in the province, connecting the Pegu and the Sittang rivers. The lakes are the Thoo, Lahgyin, and Kandaugyee.

A large part of the province is covered with forests, but the state reserved area only amounts to 133 square miles. The teak plantations lie in the Rangoon division. The total receipts from the forests in 1871–72 amounted to £77,240.

Population.—The total area of the province is 88,556 square miles; the population was returned by the census of 1872 at 2,747,148, giving an average of 31 inhabitants to the square mile. The Buddhists numbered 2,447,831, Mahometans 99,846, Hindus 36,658, Christians 52,299, and aborigines 110,514. The villages, townships, &c., numbered 14,107; the inhabited houses, 535,533. Only ten towns in the province had a population exceeding 10,000,—Rangoon, the capital, containing 98,745.

Productions.—Rice is the staple product of the province, and in 1871–72 1,836,021 acres were devoted to its cultivation. Other food grains covered 4860 acres; sesamum, 25,502 acres; sugar-cane, chiefly cultivated in the gardens around the cultivators' houses, 3179 acres; and cotton, principally grown in the hill clearings, 14,120 acres. The fibre of the indigenous cotton is short, but strong, and it adheres with great tenacity to the seed. The export of cotton is increasing. Tobacco, grown on sandbanks or in the dry beds of streams, inferior in quality, and wholly used for home consumption, occupied 12,866 acres. The other crops produced in the province are indigo, vegetables, hemp, mixed fruits, &c. The system of cultivation known in Bengal as the *júm*, that is clearing virgin soil by burning, cultivating it for one or two years, and then leaving it again to the jungle, is here extensively practised under the name of *toungya* cultivation. Although discouraged on account of its wasteful character it cannot be altogether prohibited, as it is the only means of subsistence for a large part of the population. Seven great embankments have been constructed in the province for the protection and extension

of regular cultivation. The average rent per acre of rice land varies from 1s. to 10s., while the high land, on which other grains can be cultivated, fetches generally from 3s. to 4s. per acre. Of the total area of the province (88,556 square miles) only 3414 square miles are cultivated; 51,117 square miles are cultivable, and the rest uncultivable waste

Internal Communication is chiefly carried on by water. Steamers ply on the Irawadi between Thayetmyo, Prome, Myanoung, Henzada, and Rangoon. There is also steam communication from Calcutta, *via* Akyab, to Rangoon and Moulmein, and between Tavoy and Mergui. There were, however, 814 miles of road in the province in 1871–72.

Mines.—The only mines in the province are those worked for tin in the southern portion of the Tenasserim division. This mineral (a binoxide) exists over a large extent of country in the Mergui and Tavoy districts, and is obtained by removing and washing the pebble and boulder deposits of the river beds Samples of the tin-stone, once washed, have produced about 70 per cent. of metal, and twice washed 75 per cent. The ore is therefore very rich, and the metal produced is of excellent quality. Hitherto these deposits have been washed by Chinese and natives of the country in a very rough and unscientific manner, and the tin-stone is smelted in a most primitive way, the produce realized being 68 per cent. of metal. European capitalists have now begun to turn their attention to the subject, and arrangements are being made to lease out certain tracts. Coal exists on the banks of the Tenasserim River, and in other parts of the province, but it has never been worked to any extent. Lead has been found in Toungoo, and on Maingay's Island in the Mergui Archipelago, but nothing has been done towards utilizing it. This mineral also exists in the Shwegyen district, as well as gold, antimony ore, and iron-stone. The quantity of the precious metals is, however, very small, and the workers make but a poor living Limestone exists in several parts of the province, and quarries are worked pretty extensively in Thayetmyo and Bassein; stone might also be excavated in Sandoway if a demand existed.

Manufactures.—Mills are employed in the seaport towns for husking rice and for sawing timber. There were in 1871–72 twenty-six steam rice mills in the province; five years before there were only three; and the number rapidly increases with the demand for rice for shipment to Europe, to the Straits, and to China. Silk and cotton goods are manufactured in large quantities, chiefly, however, for home use, and by small hand-looms. A loom forms a regular piece of furniture in a Burmese household; it is worked by the female members of the family. The cotton cloths thus manufactured are rough but strong; some of the silk goods fetch a high price. A coarse description of salt is made on the sea-coast, used chiefly in the preparation of *Ngapee* (a mess of half-salted, half-decomposed fish and other ingredients), which forms a favourite article of food among the Burmese. The manufacture of salt has lately fallen off, owing to the introduction of Liverpool salt, which undersells the local article. The other manufactures of the province consist of gold and silver bowls (of peculiar and elaborate workmanship), lacquered ware, carved and gilt work, and dyes, especially cutch, an extract of the *Acacia Catechu*.

Trade.—The total value of the trade of the province in 1871–72 was £10,777,705; exports, £5,452,148; imports, £5,325,557. The value of the sea-borne trade was—exports, £4,236,997; imports, £4,220,723—total, £8,457,721; and of the inland trade—exports, £1,245,150; imports, £1,104,832. The most important article of sea-borne exports is rice. The trade increased from 380,009 tons in 1865 to 470,893 tons in 1871, and made a sudden rise to 700,784 tons in 1872. Next in importance is the timber trade, shipments of which during the year 1872 amounted to 87,545 tons, of the value of £51,210. The other articles of export are cotton, cutch, hides, horns, ivory, jade stone, petroleum, rice and paddy, precious stones, stick-lac, tobacco, &c. The articles of import consist of betel-nut, cotton twist and yarn, crockery ware, cutlery, gunny bags, hardware; cotton, silk, and woollen piece goods; raw silk, spirituous liquors wines, beers, &c., sugar and tobacco.

Finances.—The gross revenue from all sources in 1871–72, £1,363,452, of which £1,217,053 was from imperial taxation, £37,320 for provincial services, and £109,079 from local funds. The land revenue of the province was £344,523. Owing to the sparse population and vast extent of country cultivable but uncultivated, the rates of assessment range low. No class of landed proprietors, like the zamindars of Bengal, exists in Burmah. The cultivators themselves hold the land from Government, the extent of their holdings averaging about 5 acres. The exceptions are, where grants of waste land have been made to Europeans or natives of India, but such grants are but little cultivated. The light land tax of the province is supplemented by a capitation tax, peculiar to Burmah; and by the rice duty, which, from the circumstances of the local trade, falls on the producer, and is equivalent to a tax of 14 per cent. *ad valorem* on this article of export. The capitation tax is a poll-tax on the male population of the province, from 18 to 60 years of age, with the exception of immigrants during the first five years of their residence, religious teachers, schoolmasters, Government servants, and those unable to obtain their own livelihood. In 1871–72 it was levied on 556,035 persons, and yielded a revenue of £226,954. The expenditure on the civil administration of the province in 1871–72 was £497,002. For the protection of British Burmah 5016 fighting men, Europeans and natives, were maintained in 1871 at a total cost of £276,200. The strength of the police in 1871 was 5319. The prisons consist of two great central gaols, Rangoon and Moulmein, chiefly for long-term convicts, with twelve subordinate gaols and lock-ups.

Education has not made much progress in British Burmah under the English plan of public instruction; but the people have a wide-spread system of primary education of their own in the monastic schools. Setting aside these monastic schools, the educational machinery of the province consists of seven Government schools, educating 505 boys; fifteen aided missionary schools, teaching 1494 pupils; and twenty-two other unaided schools under Government inspection, teaching 499 pupils.

Christianity has spread largely among the Karen tribes, chiefly through the work of American missions

Climate.—The climate of British Burmah is moist and depressing for part of the year, but cooler than that of India. Some of the forest tracts during the monsoons, and after the cold weather has set in, are impregnated with deadly malaria; but the coast and the frontier ranges are not unhealthy. The prevalent complaints amongst Europeans are fever, dysentery, and hepatic diseases, from which the natives also suffer. On the whole, however, the climate of British Burmah seems better adapted to the European constitution than any part of India, and of late the statistics of the British troops show a very low rate of disease and mortality. The rainfall varied in 1871 from 245·85 inches at Moulmein to 54·85 inches at Thayetmyo. The average temperature is greatly affected by the sea breeze,—being 80° Fahr. at the sea-coast, and 90° in the interior.

Form of Government.—The highest authority in the province of British Burmah is the chief commissioner and agent to the Governor-General of India, established under a resolution of the Government of India, dated January

1862. The chief commissioner is assisted by a secretary and assistant-secretary, three commissioners of revenue and circuit, thirteen deputy-commissioners, one superintendent of *hill-tracts*, *twenty-two assistant-commissioners*, *four* collectors of sea-customs a director of public instruction, an inspector-general of police, an inspector-general of prisons, and a conservator of forests. *A political agent is established* at the court of Mandalay, and an assistant political agent at Bhamo, for facilitating British trade with Independent Burmah and China. The judicial officers are—the recorder of Rangoon, the judicial commissioner, the judge of the town of Moulmein, the judge of the Small Cause Court, Rangoon, and three town magistrates. For history, see the preceding article.

BURMANN, Pieter (1668–1741), a Dutch classical scholar, was born at Utrecht on the 26th June 1668. He was educated at the public school in his native place, and at the age of thirteen entered the university. He devoted himself particularly to the study of the classical languages, and became unusually proficient in Latin composition. As he was intended for the legal profession he spent some years in attendance on the law classes. For about a year he studied at Leyden, paying special attention to philosophy and Greek. On his return to Utrecht he took the degree of doctor of laws (March 1688), and after travelling through Switzerland and part of Germany, settled down to the practice of law. In December 1691 he was appointed receiver of the tithes which were originally paid to the bishop of Utrecht, and five years later he was nominated to the professorship of eloquence and history. To this chair was soon added that of Greek and politics. In 1714 he paid a short visit to Paris and ransacked the libraries, bringing back a "great treasure of useful observations." In the following year he was appointed successor to the celebrated Perizonius, who had held the chair of history, Greek language, and eloquence at Leyden. His numerous editorial and critical works spread his fame as a scholar throughout Europe, and engaged him in many of the stormy disputes which were then so common among men of letters. He died on the 31st March 1741.

Of his editions of classical works the following may be noted:—*Phaedrus*, 1695; *Horace*, 1699; *Valerius Flaccus*, 1701; *Petronius Arbiter*, 1709; *Velleius Paterculus*, 1719; *Quintilian*, 1720; *Ovid*, 1727; *Lucan*, 1740. He also published an edition of Buchanan's works, continued Graevius's great work, *Thesaurus Antiquitatum et Historiarum Italiae*, and wrote a small manual of Roman antiquities, *Antiquitatum Romanarum Brevis Descriptio*, 1711. His poems and orations were published after his death.

BURNES, ... by the Royal Geographical Society of London, but also by that of Paris. Soon after his return to India in 1835 he was appointed to the court of Sindh to secure a treaty for the navigation of the Indus; and in 1836 he undertook a political mission to Dost Mohammed at Cabul. On the restoration of Shah Shujah in 1839, he became regular political agent at Cabul, and remained there till his assassination in 1841 (November 2), during the heat of an insurrection. The calmness with which he continued at his post, long after the imminence of his danger was apparent, gives an heroic colouring to the close of an honourable and devoted life. A narrative of his later labours was published in 1842 under the title of *Cabool*.

BURNET, Gilbert (1643–1715), bishop of Salisbury, was born at Edinburgh in 1643, and was descended of an ancient family of the county of Aberdeen. His father had been bred to the law, and was at the Restoration appointed one of the lords of Session, with the title of Lord Crimond. Gilbert, the youngest son, was at ten years of age sent to Marischal College, Aberdeen, where he was admitted A.M. before he was fourteen years of age. His own inclination led him to the study of the civil and feudal law; but he afterwards changed his views, and, to the great satisfaction of his father, began to apply to divinity. He received ordination before the age of eighteen; and Sir Alexander Burnet, his cousin-german, offered him a benefice, which, however, he refused to accept.

In 1663, about two years after the death of his father, he went to England; and after six months stay at Oxford and Cambridge, returned to Scotland, which he soon left again to make a tour of some months, in 1664, in Holland and France. At Amsterdam, by the help of a Jewish rabbi, he perfected himself in the Hebrew language; and likewise became acquainted with the leading men of the different persuasions tolerated in that country—Calvinists, Arminians, Lutherans, Anabaptists, Brownists, Papists, and Unitarians. In each of these sects he used frequently to declare he met with men of such unfeigned piety and virtue that he became fixed in a strong principle of universal charity, and an invincible abhorrence of all severities on account of religious dissensions.

Upon his return from his travels he was admitted minister of Saltoun, in which station he served five years in the most exemplary manner. He drew up a memorial, in which he took notice of the principal errors in the conduct of the Scottish bishops, which he observed not to be conformable to the primitive institution, and he sent a copy of it to several of them. This exposed him to their resentment; but to show he was not actuated by a spirit of ambition, he led a retired course of life for two years, which so endangered his health that he was obliged to abate his excessive application to study. In the year 1668 he was appointed professor of divinity in the university of Glasgow; and, according to the usual practice, he read his lectures in the Latin language. It was apparently at this period that he laid the chief foundation of that theological learning for which he became so distinguished. In 1669 he published his *Modest and Free Conference between a Conformist and Nonconformist*. He became acquainted with the duchess of Hamilton, who communicated to him all the papers belonging to her father and her uncle; upon which he drew up the *Memoirs of the Dukes of Hamilton*, afterwards printed at London, in folio, in the year 1677. The duke of Lauderdale, hearing that he was engaged in this work, invited him to London, and introduced him to Charles II. He returned to Scotland, and married Lady Margaret Kennedy, daughter of the earl of Cassillis, a lady of great knowledge, and highly esteemed by the Presbyterians, to whose sentiments she was strongly inclined. As there was some disparity in their ages, that it might be

sufficiently evident that the match was wholly owing to inclination, and not to avarice or ambition, the day before their marriage he delivered to the lady a deed, by which he renounced all pretensions to her fortune, which was very considerable, and must otherwise have fallen into his hands, she herself having no intention to secure it. His *Vindication of the Authority, Constitution, and Laws of the Church and State of Scotland* was printed at Glasgow, in 8vo, in the year 1673. This was considered so material a service to the Government, that he was offered a bishopric, with a promise of the next vacant archbishopric; but he did not accept of it, because he could not approve of the measures of the court, the great aim of which he perceived to be the advancement of popery. The publication itself was one of those which the author could not afterwards recollect with much satisfaction.

His intimacy with the dukes of Hamilton and Lauderdale procured him frequent messages from the king and the duke of York, who had conversations with him in private. But Lauderdale, who was the most unprincipled man of the age, conceiving a resentment against him on account of the freedom with which he spoke to him, represented at last to the king that Dr Burnet was engaged in an opposition to his measures; and on his return to London he perceived that these suggestions had entirely deprived him of the king's favour, though the duke of York treated him with greater civility than ever, and dissuaded him from going to Scotland. He accordingly resigned his professorship at Glasgow, and settled in London. About this time the living of Cripplegate being vacant, the dean and chapter of St Paul's (in whose gift it was), hearing of his circumstances, and the hardships which he had undergone, made him an offer of the benefice; but, as he had been informed of their first intention of conferring it on Dr Fowler, he generously declined it. In 1675, at the recommendation of Lord Hollis, whom he had known in France as ambassador at that court, he was appointed preacher at the Rolls chapel, by Sir Harbottle Grimstone, master of the rolls, notwithstanding the opposition of the court; and he was soon afterwards chosen lecturer at St Clement's, and became one of the most popular preachers in town. The first volume of his *History of the Reformation of the Church of England* was published in folio in 1681, the second in 1683, and the third in 1715. For this great work he received the thanks of both Houses of Parliament. Of the first two volumes he published an abridgment in the year 1683.

In 1682, when the administration was changed in favour of the duke of York, being much resorted to by persons of all ranks and parties, in order to avoid returning visits, he built a laboratory, and for above a year pursued a course of chemical experiments. Not long after he refused a country living of £300 a year offered him by the earl of Essex on condition that he should reside in London. When the inquiry concerning the popish plot was on foot he was frequently sent for and consulted by the king, who offered him the bishopric of Chichester, then vacant, if he would engage in his interests; but he refused to accept it on these terms. He preached at the Rolls till 1684, when he was dismissed by order of the court.

On the accession of James II. to the throne, having obtained leave to quit the kingdom, he first went to Paris, and lived in great retirement, till, contracting an acquaintance with Brigadier Stouppe, a Protestant gentleman in the French service, he made a tour with him into Italy. He met with an agreeable reception at Rome. Pope Innocent XI. hearing of his arrival, sent the captain of the Swiss guard to acquaint him he would give him a private audience in bed, to avoid the ceremony of kissing his holiness's slipper; but Dr Burnet excused himself as well as he could. Here, with more zeal than prudence, he engaged in some religious disputes; and, on receiving an intimation from Prince Borghese, he found it necessary to withdraw from this stronghold of priestcraft, and pursued his travels through Switzerland and Germany. He afterwards came to Utrecht, with an intention to settle in some of the seven provinces. There he received an invitation from the prince and princess of Orange (to whom their party in England had recommended him) to come to the Hague, and accepted the invitation. He was soon made acquainted with the secret of their councils, and advised the preparation of a fleet in Holland sufficient to support their designs and encourage their friends. His known share in the councils of the Prince of Orange, and the pamphlets which he sent over to England, excited against him the intensest enmity of James. A prosecution for high treason was commenced against him both in England and Scotland; but having received the intelligence before it was announced to the States he avoided the storm by petitioning for, and obtaining without any difficulty, a bill of naturalization, in order to his intended marriage with Mary Scott, a Dutch lady of considerable fortune.

Being now legally under the protection of Holland, he omitted no opportunity of supporting and promoting the design which the prince of Orange had formed of delivering Great Britain; and, having accompanied him in the capacity of chaplain, he was in the year 1689 advanced to the see of Salisbury. He declared for moderate measures with regard to the clergy who scrupled to take the oaths, and many were displeased with him for advocating the toleration of Nonconformists. "As my lord of Salisbury," says the earl of Shaftesbury, "has done more than any man living for the good and honour of the Church of England and the Reformed religion, so he now suffers more than any man from the tongues and slander of those ungrateful churchmen; who may well call themselves by that single term of distinction, having no claim to that of Christianity or Protestant, since they have thrown off all the temper of the former, and all concern or interest with the latter." The same noble writer has elsewhere mentioned him in the following terms of commendation:—"The bishop of Salisbury's *Exposition of the Articles* is, no doubt, highly worthy of your study. None can better explain the sense of the church than one who is the greatest pillar of it since the first founders,—one who best explained and asserted the Reformation itself, was chiefly instrumental in saving it from Popery before and at the Revolution, and is now the truest example of laborious, primitive, pious, and learned episcopacy."[1]

In 1693, after the publication and condemnation of Blount's anonymous pamphlet, *King William and Queen Mary Conquerors* (see BLOUNT), an opportunity was taken by Burnet's enemies to bring a pastoral letter of his before the House of Commons. After a warm discussion the letter was condemned to be burned by the common hangman.

In 1698 he lost his wife by the small-pox; and as he was almost immediately after appointed preceptor to the duke of Gloucester, of whose education he took great care, this employment, and the tender age of his children, induced him the same year to supply her loss by a marriage with Mrs Berkeley, a widow, who was eldest daughter of Sir Richard Blake. In 1699 he published his *Exposition of the Thirty-nine Articles*, which occasioned a charge against him in the Lower House of Convocation in the year 1701, but he was vindicated in the Upper House. His speech in the House of Lords in 1704 against the Bill to prevent occasional conformity was severely attacked. He

[1] Shaftesbury's *Letters*, p. 28, 37.

formed a scheme for augmenting the small livings, which he pressed forward with such success, that an Act of Parliament was passed in the second year of Queen Anne, for the augmentation of the livings of the poor clergy. He died in 1715, and was interred in the church of St James's, Clerkenwell, where a monument was erected to his memory.

Bishop Burnet's *History of his Own Time*, consisting of two large volumes in folio, was not published till several years after the author's death; the first volume appeared in 1724, and the second in 1734. An account of his life was added by his youngest son Sir Thomas Burnet, one of the judges of the Court of Common Pleas. The *History* itself was not printed without mutilations; but after an interval of nearly a century, an edition containing all the passages which had formerly been suppressed, was published under the superintendence of the learned Dr Routh. (Oxford, 1823, 6 vols. 8vo.) This is a work of great and intrinsic value; without it our knowledge of the times would be exceedingly imperfect. His materials are not always very carefully digested, and the style is sometimes supposed to be too familiar; but these defects are abundantly compensated for by the copiousness of his information, the benevolence of his sentiments, and the earnestness of his manner. In general Burnet's statements may be accepted with great confidence, his judgment is always sound and sober, and he possesses considerable skill in the delineation of character. The best editions of his two great works are—*History of his Own Time*, 6 vols., Oxford, 1833; *History of the Reformation*, 7 vols., by N. Pocock, 1865.

Besides the works mentioned above the following are worthy of notice:—*Some Passages of the Life and Death of John Earl of Rochester*,[1] Lond. 1680, 8vo; *The Life and Death of Sir Matthew Hale, Kt., sometime Lord Chief-Justice of his Majestie's Court of Kings Bench*, Lond. 1682, 8vo; *The History of the Rights of Princes in disposing of Ecclesiastical Benefices and Church Lands*, Lond. 1682, 8vo; *The Life of William Bedell, D.D., Bishop of Kilmore in Ireland*, Lond. 1685, 8vo; *Reflections on Mr Varillas's "History of the Revolutions that have happened in Europe in matters of Religion," and more particularly on his Ninth Book, that relates to England*, Amst. 1686, 12mo; *A Defence of the Reflections on the Ninth Book of the first volume of Mr Varillas's "History of Heresies," being a Reply to his Answer*, Amst. 1687, 12mo; *A Continuation of Reflections on Mr Varillas's "History of Heresies," particularly on that which relates to English Affairs in his Third and Fourth tomes*, Amst. 1687, 12mo. He took a very conspicuous part in the continued controversy which was in his time maintained against the papists; and a complete catalogue of his polemical works would occupy no small space. The following translations deserve to be mentioned:—*Utopia, written in Latin by Sir Thomas More, Chancellor of England: translated into English*, Lond. 1685, 8vo; *A Relation of the Death of the Primitive Persecutors, written originally in Latin, by L. C. F. Lactantius: Englished by Gilbert Burnet, D.D., to which he hath made a large preface concerning Persecution*, Amst. 1687, 12mo.

BURNET, Thomas (1635–1715), best known as the author of *The Sacred Theory of the Earth*, was born at Croft in Yorkshire about the year 1635, but is supposed to have been descended of a Scottish family. He was educated at the free school of Northallerton, and in June 1651 was admitted a pensioner of Clare Hall at Cambridge, under the tuition of Tillotson, who continued to remember him with kindness. In the year 1654 he removed to Christ's College, on the election of Dr Cudworth to the mastership, and there he obtained a fellowship in the year 1657. In 1661 he became senior proctor of the university. He was successively domestic tutor to Charles duke of Bolton, and to James earl of Ossory, afterwards duke of Ormond, grandson to the first duke; and by the interest of the latter nobleman he was chosen master of the Charterhouse in 1685. Among the electors some of the bishops opposed him on account of his wearing a lay habit; but the duke was satisfied that he possessed the more essential qualifications of a life and conversation suitable to his clerical character. After this appointment he took the degree of D.D. In his capacity of master he made a noble stand against the illegal attempts to admit Andrew Popham as a pensioner of the house, strenuously opposing an order of the 26th of December 1686, addressed by James II. to the governors dispensing with the statutes for the occasion.

Dr Burnet published his *Telluris Theoria Sacra*, or *Sacred Theory of the Earth*, at London in 1681. This work, containing a fanciful theory of the earth's structure, attracted an unusual share of public attention, and he was afterwards encouraged to issue an English translation, which was printed in folio, 1684–1689. Addison commended the author in a Latin ode, but his theory was attacked by Dr Keill, Mr Whiston, and Mr Warren, to all of whom he returned answers. His reputation obtained for him an introduction at court by Archbishop Tillotson, whom he succeeded as clerk of the closet to King William. He seemed already to be on the direct road to much higher preferment, when he suddenly marred his prospects by the publication, in 1692, of a work entitled *Archæologiæ Philosophicæ: sive Doctrina antiqua de Rerum Originibus*, in which he treated the Mosaic account of the fall of man as an allegory. The method of treatment excited a great clamour against him; and the king was obliged to remove him from his office at court. Of this book an English translation was executed by Mr Foxton, Lond. 1729, 8vo. Dr Burnet published several other minor works before his death, which took place at the Charter-house on the 27th September 1715. Two posthumous works were published several years after his death—*De Fide et Officiis Christianorum*, 1723, and *De Statu Mortuorum et Resurgentium Tractatus*, 1723; in which he maintained the doctrine of a middle state, the millennium, and the limited duration of future punishment. A *Life of Dr Burnet* by Heathcote appeared in 1759.

BURNETT, James, Lord Monboddo. See Monboddo.

BURNEY, Charles, Doctor of Music (1726–1814), was born in the ancient city of Shrewsbury, the capital of Shropshire, on the 7th of April 1726. He received his earlier education at the excellent free school of that city, and was afterwards sent to the public school at Chester. His first music master was Mr Baker, organist of Chester Cathedral, and a pupil of Dr John Blow. Returning to Shrewsbury when about fifteen years old, he continued his musical studies for three years under his half-brother, Mr James Burney, organist of St Mary's Church, and was then sent to London as a pupil of the celebrated Dr Arne, with whom he remained three years. In 1749 he was appointed organist of a church in the city, with a salary of £30 a year; and he was also engaged as conductor of a concert established at the King's Arms, Cornhill. In that year and the next he composed the music of three dramas for Drury Lane theatre—*Alfred*, *Robin Hood*, and *Queen Mab*. Being threatened with a pulmonary affection he went, on the advice of his physician, in 1751 to Lynn, in Norfolk, where he was elected organist, with an annual salary of £100, and where he resided for the next nine years. During that time he began to entertain the idea of writing a general history of music. In 1760 he returned to London in good health, and with a young family; the eldest of whom, a girl of eight years of age, surprised the public by her attainments as a harpsichord player. In 1766 he produced, at Drury lane, a free English version and adaptation of J. J. Rousseau's operetta *Le Devin du Village*, under the title of *The Cunning Man*, which was favourably received. The university of Oxford conferred

[1] "Which," says Dr Johnson, "the critick ought to read for its elegance, the philosopher for its arguments, and the saint for its piety" (*Lives of English Poets*, vol. i. p. 303).

upon him, on 23d June 1769, the degrees of bachelor and doctor of music, on which occasion he presided at the performance of his exercise for these degrees. This consisted of an anthem, with an overture, solos, recitatives, and choruses, accompanied by instruments, besides a vocal anthem in eight parts, which was not performed. His friend, C. P. E. Bach, requested a copy of this exercise, and had it performed in St Catharine's Church at Hamburg, under his own direction, in 1773. It was repeatedly performed at Oxford, "after it had fufilled its original destination," as Burney tells us (*Hist. of Music*, vol. iii. p. 329); and he apologizes as follows for saying so much about it:—"It is hoped that the reader will pardon this *egotism*, which has been extorted from me by occasional and sinister assertions, 'that I neither liked nor had studied church music.'" (*Ibid*). In 1769 he published *An Essay towards a History of Comets*. Amidst his various professional avocations, Burney never lost sight of his favourite object,—his *History of Music*,—and therefore resolved to travel abroad for the purpose of collecting materials that could not be found in Great Britain. Accordingly, he left London in June 1770, furnished with numerous letters of introduction, and proceeded to Paris, and thence to Genevá, Turin, and the principal cities of Italy. The results of his observations he published in *The Present State of Music in France and Italy* (1 vol. 8vo, London, 1771). Dr Johnson thought so well of this work, that, alluding to his own *Journey to the Western Islands of Scotland*, he said, "I had that clever dog Burney's Musical Tour in my eye." In July 1772 Burney again visited the Continent, to collect further materials, and, after his return to London, published his tour under the title of *The Present State of Music in Germany, the Netherlands, and United Provinces* (2 vols. 8vo, London, 1773). In 1773 he was chosen a Fellow of the Royal Society of London. In 1776 appeared the first volume (in 4to) of his long-projected *History of Music*; in 1782 the second volume; and in 1789 the third and fourth. Though severely criticised by Forkel in Germany and by the Spanish ex-Jesuit, Requeno, who, in his Italian work *Saggj sul Ristabilimento dell' Arte Armonica de' Greci e Romani Cantori*, Parma, 1798 (2 vols. 8vo), attacks Burney's account of the ancient Greek music, and calls him *lo scompigliato Burney*, the *History of Music* was generally recognized as possessing great merit. The least satisfactory volume is the fourth, the treatment of Handel and Bach being quite inadequate. Burney's first Tour was translated into German by Ebeling, and printed at Hamburg in 1772; and his second Tour, translated into German by Bode, was published at Hamburg in 1773. A Dutch translation of his second Tour, with notes by J. W. Lustig, organist at Groningen, was published there in 1786 The Dissertation on the Music of the Ancients, in the first volume of Burney's *History*, was translated into German by J. J. Eschenburg, and printed at Leipsic, 1781. Burney derived much aid from the first two volumes of Padre Martini's very learned *Storia della Musica*, Bologna, 1757–1770. One cannot but admire his persevering industry, and his sacrifices of time, money and personal comfort, in collecting and preparing materials for his *History*; and few will be disposed to condemn severely errors and oversights in a work of such extent and difficulty. In 1779 he wrote for the Royal Society an account of the infant Crotch, whose remarkable musical talent excited so much attention at that time In 1784 he published, with an Italian title-page, the music annually performed in the Pope's chapel at Rome during Passion Week. In 1785 he published, for the benefit of the Musical Fund, an account of the first commemoration of Handel in Westminster Abbey in the preceding year, with an excellent life of Handel. In 1796 he published *Memoirs and Letters of Metastasio*, 3 vols. 8vo. Towards the close of his life, Burney contributed to the Rev. Dr Rees's *Cyclopædia* all the musical articles not belonging to the department of Natural Philosophy and Mathematics. For these articles he received £1000, which seems a remarkable remuneration, considering that most of his materials were merely transcribed from his own *History of Music*. In 1789, through the treasury influence of his friend Edmund Burke, he was appointed organist to the chapel of Chelsea Hospital, and he resided in the hospital for the remainder of his life. He was made a member of the Institute of France, and nominated a correspondent in the class of the Fine Arts, in the year 1810. He died at Chelsea College on the 12th of April 1814, and was interred in the burying-ground of the college on the 20th of the same month.

Burney had a wide circle of acquaintance among the distinguished artists and literary men of his day. At one time he thought of writing a life of his friend Dr Samuel Johnson; but he retired before the crowd of biographers who rushed into that field. His character in private as well as public life appears to have been very amiable and exemplary. Dr Burney's eldest son, James, was a distinguished officer in the royal navy, and died a rear-admiral in 1821. He published several works of merit. A notice of his second son, the Rev. Charles Burney, D.D., an eminent Greek scholar, will be found below, and of his second daughter Frances (Madame D'Arblay) under the heading D'Arblay. The *Diary and Letters* of Madame D'Arblay contain many minute and interesting particulars of her father's public and private life, and of his friends and contemporaries. A life of her father, by Madame D'Arblay, appeared in 1832.

Besides the operatic music above mentioned, Burney's known compositions consist of—1. *Six Sonatas for the harpsichord*; 2. *Two Sonatas for the harp or piano, with accompaniments for violin and violoncello*; 3. *Sonatas for two violins and a bass: two sets*; 4. *Six Lessons for the harpsichord*; 5. *Six Duets for two German flutes*; 6. *Three Concertos for the harpsichord*; 7. *Six concert pieces with an introduction and fugue for the organ*; 8. *Six Concertos for the violin, &c., in eight parts*; 9. *Two Sonatas for pianoforte, violin, and violoncello*; 10. *A Cantata, &c.*; 11. *Anthems, &c.*; 12. *XII. Canzonetti a due voci in Canone, poesia dell' Abate Metastasio.*

BURNEY, Charles (1757–1817), son of the preceding, an eminent classical scholar, was born at Lynn, in Norfolk, in 1757. At the age of eleven he was sent to the Charterhouse in London, whence he removed to Caius College, Cambridge. He quitted the university without taking his degree; but in 1791 he received the diploma of LL.D. from Aberdeen, and in 1808 that of D.D. from Cambridge. In 1783 he married the daughter of Dr Rose, the translator of Sallust, and continued for some time to assist his father-in-law in the management of his academy. He contributed at this time many articles to the *Monthly Review*, and afterwards edited for two or three years the *London Magazine*. Some of his contributions to the first of these periodicals gained him much credit not only among English but among Continental scholars. In the course of time he realized a handsome fortune, great part of which he expended in the formation of his splendid library. The manuscripts and rare books collected by him were considered so valuable that at his death, which happened in 1817, they were purchased by the nation and deposited in the British Museum.

BURNEY, Frances. See D'Arblay.

BURNLEY, a manufacturing town and municipal and parliamentary borough of England, 22 miles N. of Manchester, in a valley on the River Burn, from which it derives it name, and in the immediate vicinity of the Leeds and Liverpool canal. Its streets are well paved, and there is an abundant supply of water. Among its buildings of note are the frequently restored church of St Peter's; a market hall, erected in 1866; and a literary institution

and exchange. It also possesses a Church of England institute, with a considerable library, a free grammar school, and several charities. Its staple manufacture is cotton, which in 1872 gave employment to 7972 men and 8267 women of twenty years of age and upwards. Worsted, which was formerly the chief article, is still manufactured to a considerable extent. Calico-printing, machine-making, brewing, tanning, and several other important industries are carried on in the town; and in the neighbourhood there are iron mines and stone quarries, which gave employment in 1872 to 1376 and 360 workmen respectively. From the number of Roman remains found at various times on the spot, Burnley seems to be the site of some Roman station; and it has also been suggested that it may coincide with Brunnanburh, the famous battle-field of the Saxons. There are but few facts of importance in its history. During the cotton famine it suffered severely, and the operatives were employed in an extensive system of improvements, to which the present satisfactory condition of the town is mainly due. In 1861 it was incorporated by royal charter, the government being placed in the hands of a mayor, eight aldermen, and twenty-four councillors; and in 1867 it was entrusted with the right of electing one member of Parliament. The population of the parliamentary borough in 1871 was 44,320 persons, of whom 21,368 were males and 22,952 females; the inhabited houses were 8804, and the registered electors 5628.

BURNOUF, EUGÈNE (1801–1852), an Oriental scholar, was born at Paris in 1801. He was educated for the legal profession, but soon after taking his degree began to devote himself entirely to the study of Oriental languages. In 1826 he published an *Essai sur le Pali*, and in the following year *Observations Grammaticales sur quelques Passages de l'Essai sur le Pali*. The next great work he undertook was the deciphering of the Zend manuscripts brought to France by Anquetil du Perron. By his labours a knowledge of the Persian language and religion was first brought into the scientific world of Europe. He caused the *Vendidad Sadé* to be lithographed with the utmost care, and published it in folio, 1829–43. The contributions he made to Oriental literature in the *Journal Asiatique* were numerous and important. From 1833 to 1835 he published his *Commentaries sur le Yaçna, l'un des livres liturgiques des Perses*; in 1840 he began the publication of the Sanskrit text and French translation of the *Bhagavata Purana*, which was completed in three folio volumes. His last works were *Introduction à l'Histoire du Bouddhisme Indien*, and a translation of *Le Lotus de la Bonne Loi*. The latter work was passing through the press when the author died on the 28th May 1852 He was a member of the *Académie des Inscriptions*, and from 1832 had held the post of professor of Sanskrit in the Collége de France.

BURNOUF, JEAN LOUIS (1775–1844), the father of Eugène Burnouf, was born in 1775. During the intervals of leisure left him by his commercial employment he prosecuted his studies in classical literature, and in 1808 was appointed assistant-professor at the Lycée Charlemagne. He soon afterwards obtained the chair of rhetoric at the Lycée Imperial, which he held till 1826, when he was made the inspector of the Academy. In 1817 he had been appointed professor of Latin eloquence at the Collége de France, and from 1811 to 1822 he acted as president of the École Normale. In 1830 Burnouf was named inspector-general of studies, and on his resignation of this post in 1836 was made librarian of the university. He died in 1844. His most important work was the *Méthode pour étudier la Langue Grecque*, 1814, which marks an epoch in the study of Greek in France. He also published a valuable edition of Sallust and some excellent translations of Tacitus, and of parts of Sallust and Cicero.

BURNS, ROBERT (1759–1796). In a company of German critics who were weighing the claims and estimating the rank of the poets, their contemporaries, the leader of their chorus, the genial humorist, Jean Paul Richter, is said to have hushed his audience when the name of Goethe was introduced, exclaiming—"We are not to sit in judgment on that sacred head." Scotsmen are apt to attach the same half-superstitious reverence to the name which is, more than any other, that of Scotland condensed in a personality, the representative of what is noblest and also of much that is erring in their race.

Robert Burns was born on the 25th of January 1759, in a cottage about two miles from Ayr, the eldest son of a small farmer, William Burness, of Kincardineshire stock, who wrought hard, practised integrity, wished to bring up his children in the fear of God, but had to fight all his days against the winds and tides of adversity. "The poet," says Mr Carlyle, his best biographer, "was fortunate in his father—a man of thoughtful intense character, as the best of our peasants are, valuing knowledge, possessing some and open-minded for more, of keen insight and devout heart, friendly and fearless: a fully unfolded man seldom found in any rank in society, and worth descending far in society to seek. . . . Had he been ever so little richer, the whole might have issued otherwise. But poverty sunk the whole family even below the reach of our cheap school system, and Burns remained a hard-worked plough-boy."

Through a series of migrations from one unfortunate farm to another; from Alloway (where he was taught to read), to Mt. Oliphant, and then (1777) to Lochlea in Tarbolton (where he learnt the rudiments of geometry), the poet remained in the same condition of straitened circumstances. At the age of thirteen he thrashed the corn with his own hands, at fifteen he was the principal labourer. The family kept no servant, and for several years butchers' meat was a thing unknown in the house. "This kind of life," he writes, "the cheerless gloom of a hermit and the unceasing toil of a galley-slave, brought me to my sixteenth year." His naturally robust frame was overtasked, and his nervous constitution received a fatal strain. His shoulders were bowed, he became liable to headaches, palpitations, and fits of depressing melancholy. From these hard tasks and his fiery temperament, craving in vain for sympathy in a frigid air grew the strong temptations on which Burns was largely wrecked,—the thirst for stimulants and the revolt against restraint which soon made headway and passed all bars. In the earlier portions of his career, a buoyant humour bore him up; and amid thick-coming shapes of ill he bated no jot of heart or hope. He was cheered by vague stirrings of ambition, which he pathetically compares to the "blind groping of Homer's Cyclops round the walls of his cave." Sent to school at Kirkoswald, he became, for his scant leisure, a great reader—eating at meal-times with a spoon in one hand and a book in the other,—and carrying a few small volumes in his pocket to study in spare moments in the fields. "The collection of songs," he tells us, "was my *vade mecum*. I pored over them driving my cart or walking to labour, song by song, verse by verse, carefully noting the true, tender, sublime, or fustian." He lingered over the ballads in his cold room by night; by day, whilst whistling at the plough, he invented new forms and was inspired by fresh ideas, "gathering round him the memories and the traditions of his country till they became a mantle and a crown." It was among the furrows of his father's fields that he was inspired with the perpetually quoted wish—

> "That I for poor auld Scotland's sake
> Some useful plan or book could make,
> Or sing a sang at least."

An equally striking illustration of the same feeling is to be found in his summer Sunday's ramble to the Leglen

wood,—the fabled haunt of Wallace,—which the poet confesses to have visited "with as much devout enthusiasm as ever pilgrim did the shrine of Loretto." In another reference to the same period he refers to the intense susceptibility to the homeliest aspects of Nature which throughout characterized his genius. "Scarcely any object gave me more—I do not know if I should call it pleasure—but something which exalts and enraptures me—than to walk in the sheltered side of a wood or high plantation in a cloudy winter day and hear the stormy wind howling among the trees and raving over the plain. I listened to the birds, and frequently turned out of my path lest I should disturb their little songs or frighten them to another station." Auroral visions were gilding his horizon as he walked in glory, if not in joy, "behind his plough upon the mountain side;" but the swarm of his many-coloured fancies was again made grey by the *atra cura* of unsuccessful toils.

Burns had written his first verses of note, "Behind yon hills where Stinchar (afterwards Lugar) flows," when in 1781 he went to Irvine to learn the trade of a flax-dresser. "It was," he says, "an unlucky affair. As we were giving a welcome carousal to the New Year, the shop took fire and burned to ashes; and I was left, like a true poet, without a sixpence." His own heart, too, had unfortunately taken fire. He was poring over mathematics till, in his own phraseology,—still affected in its prose by the classical pedantries caught from Pope by Ramsay,—"the sun entered Virgo, when a charming *fillette*, who lived next door, overset my trigonometry, and set me off at a tangent from the scene of my studies." We need not detail the story, nor the incessant repetitions of it, which marked and sometimes marred his career. The poet was jilted, went through the usual despairs, and resorted to the not unusual sources of consolation. He had found that he was "no enemy to social life," and his mates had discovered that he was the best of boon companions in the lyric feasts, where his eloquence shed a lustre over wild ways of life, and where he was beginning to be distinguished as a champion of the New Lights and a satirist of the Calvinism whose waters he found like those of Marah.

In Robert's 25th year his father died, full of sorrows and apprehensions for the gifted son who wrote for his tomb, in Alloway kirkyard, the fine epitaph ending with the characteristic line—

"For even his failings leaned to virtue's side.'

For some time longer the poet, with his brother Gilbert, lingered at Lochlea, reading agricultural books, miscalculating crops, attending markets, and in a mood of reformation resolving, "in spite of the world, the flesh, and the devil, to be a wise man." Affairs, however, went no better with the family; and in 1784 they migrated to Mossgiel, where he lived and wrought, during four years, for a return scarce equal to the wage of the commonest labourer in our day. Meanwhile he had become intimate with his future wife, Jean Armour; but the father, a master mason, discountenanced the match, and the girl being disposed to "sigh as a lover," as a daughter to obey, Burns, in 1786, gave up his suit, resolved to seek refuge in exile, and having accepted a situation as book-keeper to a slave estate in Jamaica, had taken his passage in a ship for the West Indies. His old associations seemed to be breaking up, men and fortune scowled, and "hungry ruin had him in the wind," when he wrote the lines ending—

"Adieu, my native banks of Ayr,"

and addressed to the most famous of the loves, in which he was as prolific as Catullus or Tibullus, the proposal—

"Will ye go to the Indies, my Mary.

He was withheld from his project and, happily or unhappily, the current of his life was turned by the success of his first volume, which was published at Kilmarnock in June 1786. It contained some of his most justly celebrated poems, the results of his scanty leisure at Lochlea and Mossgiel; among others "The Twa dogs,"—a graphic idealization of Æsop,—"The Author's Prayer," the "Address to the Deil," "The Vision" and "The Dream," "Halloween," "The Cottar's Saturday Night," the lines "To a Mouse" and "To a Daisy," "Scotch Drink," "Man was made to Mourn," the "Epistle to Davie," and some of his most popular songs. This epitome of a genius so marvellous and so varied took his audience by storm. "The country murmured of him from sea to sea." "With his poems," says Robert Heron, "old and young, grave and gay, learned and ignorant, were alike transported. I was at that time resident in Galloway, and I can well remember how even plough-boys and maid-servants would have gladly bestowed the wages they earned the most hardly, and which they wanted to purchase necessary clothing, if they might but procure the works of Burns. This first edition only brought the author £20 direct return, but it introduced him to the *literati* of Edinburgh, whither he was invited, and where he was welcomed, feasted, admired, and patronized. He appeared as a portent among the scholars of the northern capital and its university, and manifested, according to Mr Lockhart, "in the whole strain of his bearing, his belief that in the society of the most eminent men of his nation he was where he was entitled to be, hardly deigning to flatter them by exhibiting a symptom of being flattered."

Sir Walter Scott bears a similar testimony to the dignified simplicity and almost exaggerated independence of the poet, during this *annus mirabilis* of his success. "As for Burns, *Virgilium vidi tantum*, I was a lad of fifteen when he came to Edinburgh, but had sense enough to be interested in his poetry, and would have given the world to know him. I saw him one day with several gentlemen of literary reputation, among whom I remember the celebrated Dugald Stewart. Of course we youngsters sat silent, looked, and listened. . . . I remember . . . his shedding tears over a print representing a soldier lying dead in the snow, his dog sitting in misery on one side, on the other his widow with a child in her arms. His person was robust, his manners rustic, not clownish. . . . His countenance was more massive than it looks in any of the portraits. There was a strong expression of shrewdness in his lineaments; the eye alone indicated the poetic character and temperament. It was large and of a dark cast, and literally glowed when he spoke with feeling or interest. I never saw such another eye in a human head. His conversation expressed perfect self-confidence, without the least intrusive forwardness. I thought his acquaintance with English poetry was rather limited; and having twenty times the abilities of Allan Ramsay and of Ferguson he talked of them with too much humility as his models. He was much caressed in Edinburgh, but the efforts made for his relief were extremely trifling." *Laudatur et alget.* Burns went from those meetings, where he had been posing professors (no hard task), and turning the heads of duchesses, to share a bed in the garret of a writer's apprentice,—they paid together 3s. a week for the room. It was in the house of Mr Carfrae, Baxter's Close, Lawnmarket, "first scale stair on the left hand in going down, first door in the stair." During Burns's life it was reserved for William Pitt to recognize his place as a great poet, the more cautious critics of the North were satisfied to endorse him as a rustic prodigy, and brought upon themselves a share of his satire. Some of the friendships contracted during this period—as for Lord Glencairn and Mrs Dunlop—are among the most pleasing and permanent in literature; for genuine kind-

ness was never wasted on one who, whatever his faults, has never been accused of ingratitude. But in the bard's city life there was an unnatural element. He stooped to beg for neither smiles nor favour, but the gnarled country oak is cut up into cabinets in artificial prose and verse. In the letters to Mr Graham, the prologue to Mr Wood, and the epistles to Clarinda, he is dancing minuets with hob-nailed shoes. When, in 1787, the second edition of the *Poems* came out, the proceeds of their sale realized for the author £400. On the strength of this sum he gave himself two long rambles, full of poetic material—one through the border towns into England as far as Newcastle, returning by Dumfries to Mauchline, and another a grand tour through the East Highlands, as far as Inverness, returning by Edinburgh, and so home to Ayrshire.

In 1788 Burns took a new farm at Ellisland on the Nith, settled there, married, lost his little money, and wrote, among other pieces, "Auld Lang Syne" and "Tam O' Shanter." In 1789 he obtained, through the good office of Mr Graham of Fintry, an appointment as excise-officer of the district, worth £50 per annum. In 1791 he removed to a similar post at Dumfries worth £70. In the course of the following year he was asked to edit and supply the *Melodies of Scotland with Symphonies and Accompaniments for the Pianoforte and Violin: the poetry by Robert Burns.* To this work he contributed about one hundred songs, the best of which are now ringing in the ear of every Scotchman from New Zealand to San Francisco. For these, original and adapted, he received a shawl for his wife, a picture by David Allan representing the "Cottar's Saturday Night," and £5! The poet wrote an indignant letter and never afterwards composed for money. Unfortunately the "Rock of Independence" to which he had proudly retired was but a castle of air, over which the meteors of French political enthusiasm cast a lurid gleam. In the last years of his life, exiled from polite society on account of his revolutionary opinions, he became sourer in temper and plunged more deeply into the dissipations of the lower ranks, among whom he found his only companionship and sole, though shallow, sympathy. To have Jacobin tendencies, to rejoice at the downfall of the Bastille, was regarded as the sign of an abandoned character, as it was twelve years ago in Scotland to embrace the cause of the Northern States in the American War.

Burns began to feel himself prematurely old. Walking with a friend who proposed to him to join a county ball, he shook his head, saying "that's all over now," and adding a verse of Lady Grissel Baillie's ballad—

> "O were we young as we ance hae been,
> We sud hae been galloping down on yon green,
> And linking it ower the lily-white lea,
> But were na my heart light I wad dee."

His hand shook; his pulse and appetite failed; his spirits sunk into a uniform gloom. In April 1796 he wrote—"I fear it will be some time before I tune my lyre again. By Babel's streams I have sat and wept. I have only known existence by the pressure of sickness and counted time by the repercussions of pain. I close my eyes in misery and open them without hope. I look on the vernal day and say with poor Ferguson—

> "Say wherefore has an all-indulgent heaven
> Life to the comfortless and wretched given."

On the 4th of July he was seen to be dying. On the 12th he wrote to his cousin for the loan of £10 to save him from passing his last days in jail. On the 21st he was no more. On the 25th, when his last son came into the world, he was buried with local honours, the volunteers of the company to which he belonged firing three volleys over his grave.

It has been said that "Lowland Scotland as a distinct nationality came in with two warriors and went out with two bards. It came in with William Wallace and Robert Bruce and went out with Robert Burns and Walter Scott. The first two made the history, the last two told the story and sung the song." But what in the minstrel's lay was mainly a requiem was in the people's poet also a prophecy. The position of Burns in the progress of our literature may be shortly defined; he was a link between two eras, like Chaucer, the last of the old and the first of the new—the inheritor of the traditions and the music of the past, in some respects the herald of the future.

The volumes of our lyrist owe part of their popularity to the fact of their being an epitome of melodies, moods, and memories that had belonged for centuries to the national life, the best inspirations of which have passed into them. But in gathering from his ancestors Burns has exalted their work by asserting a new dignity for their simplest themes. He is the heir of Barbour, distilling the spirit of the old poet's epic into a battle chant, and of Dunbar, reproducing the various humours of a half-sceptical, half-religious philosophy of life. He is the pupil of Ramsay, but he leaves his master, to make a social protest and to lead a literary revolt. The *Gentle Shepherd*, still largely a court pastoral, in which "a man 's a man" if born a gentleman, may be contrasted with the "Jolly Beggars"—the one is like a minuet of the ladies of Versailles on the sward of the Swiss village near the Trianon, the other like the march of the mænads with Theroigne de Mericourt. Ramsay adds to the rough tunes and words of the ballads the refinement of the wits who in the "Easy" and "Johnstone" clubs talked over their cups of Prior and Pope, Addison and Gay. Burns inspires them with a fervour that thrills the most wooden of his race. We may clench the contrast by a representative example. This is from Ramsay's version of perhaps the best known of our songs,—

> "Methinks around us on each bough
> A thousand Cupids play;
> Whilst through the groves I walk with you,
> Each object makes me gay.
> Since your return—the sun and moon
> With brighter beams do shine,
> Streams murmur soft notes while they run
> As they did lang syne."

Compare the verses in Burns—

> "We twa hae run about the braes
> And pou't the gowans fine;
> But we've wandered mony a weary foot
> Sin auld lang syne.
> We twa hae paidl'd in the burn,
> Frae morning sun till dine:
> But seas between us braid hae roar'd
> Sin auld lang syne."

Burns as a poet of the inanimate world doubtless derived hints from Thomson (*i.e.*, the poet, not his correspondent), but in his power of tuning its manifestations to the moods of the mind he is more properly ranked as a forerunner of Wordsworth. He never follows the fashions of his century, except in his failures—in his efforts at set panegyric or fine letter-writing. His highest work knows nothing of "Damon" or "Musidora." He leaves the atmosphere of drawing-rooms for the ingle or the ale-house or the mountain breeze.

The affectations of his style are insignificant and rare. His prevailing characteristic is an absolute sincerity. A love for the lower forms of social life was his besetting sin; Nature was his healing power. Burns compares himself to an Æolian harp, strung to every wind of heaven. His genius flows over all living and lifeless things with a sympathy that finds nothing mean or insignificant. An uprooted daisy becomes in his pages an enduring emblem of the fate of artless maid and simple bard. He disturbs

a mouse's nest and finds in the "tim'rous beastie" a fellow-mortal doomed like himself to "thole the winter's sleety dribble," and draws his oft-repeated moral. He walks abroad and, in a verse that glints with the light of its own rising sun before the fierce sarcasm of the "Holy Fair," describes the melodies of a "simmer Sunday morn." He loiters by Afton Water and "murmurs by the running brook a music sweeter than its own." He stands by a roofless tower, where "the howlet mourns in her dewy bower," and "sets the wild echoes flying," and adds to a perfect picture of the scene his famous vision of "Libertie." In a single stanza he concentrates the sentiment of many Night Thoughts—

> "The pale moon is setting beyond the white wave,
> And Time is setting wi' me, O."

For other examples of the same graphic power we may refer to the course of his stream—

> "Whiles ow'r a linn the burnie plays
> As through the glen it wimpled," &c.,

or to the "Birks of Aberfeldy" or the "spate" in the dialogue of the "Brigs of Ayr." The poet is as much at home in the presence of this flood as by his "trottin' burn's meander." Familiar with all the seasons, he represents the phases of a northern winter with a frequency characteristic of his clime and of his fortunes; her tempests become anthems in his verse, and the sounding woods "raise his thoughts to Him that walketh on the wings of the wind;" full of pity for the shelterless poor, the "ourie cattle," the "silly sheep," and the "helpless birds," he yet reflects that the bitter blast is not "so unkind as man's ingratitude." This constant tendency to ascend above the fair or wild features of outward things, or to penetrate beneath them, to make them symbols, to endow them with a voice to speak for humanity, distinguishes Burns as a descriptive poet from the rest of his countrymen. As a painter he is rivalled by Dunbar and James I., more rarely by Thomson and Ramsay. The "lilt" of Tannahill's finest verse is even more charming. But these writers rest in their art; their main care is for their own genius. The same is true in a minor degree of some of his great English successors. Keats has a palette of richer colours, but he seldom condescends to "human nature's daily food." Shelley floats in a thin air to stars and mountain tops, and vanishes from our gaze like his skylark. Byron, in the midst of his revolutionary fervour, never forgets that he himself belongs to the "caste of Vere de Vere." Wordsworth's placid affection and magnanimity stretch beyond mankind, and, as in "Hart-leap-well" and the "Cuckoo," extend to bird and beast; he moralizes grandly on the vicissitudes of common life, but he does not enter into, because by right of superior virtue he places himself above them. "From the Lyrical Ballads," it has been said, "it does not appear that men eat or drink, marry or are given in marriage." We revere the monitor who, consciously good and great, gives us the dry light of truth, but we love the bard, *nostræ deliciæ*, who is all fire—fire from heaven and Ayrshire earth mingling in the outburst of passion and of power, which is his poetry and the inheritance of his race. He had certainly neither culture nor philosophy enough to have written the "Ode on the Recollections of Childhood," but to appreciate that ode requires an education. The sympathies of Burns, as broad as Wordsworth's, are more intense; in turning his pages we feel ourselves more decidedly in the presence of one who joys with those who rejoice and mourns with those who mourn. He is never shallow, ever plain, and the expression of his feeling is so terse that it is always memorable. Of the people he speaks more directly for the people than any of our more considerable poets. Chaucer has a perfect hold of the homeliest phases of life, but he wants the lyric element, and the charm of his language has largely faded from untutored ears. Shakespeare, indeed, has at once a loftier vision and a wider grasp; for he sings of "Thebes and Pelops line," of Agincourt and Philippi, as of Falstaff, and Smug the joiner, and the "meanest flower that blows." But not even Shakespeare has put more thought into poetry which the most prosaic must appreciate than Burns has done. The latter moves in a narrower sphere and wants the strictly dramatic faculty, but its place is partly supplied by the vividness of his narrative. His realization of incident and character is manifested in the sketches in which the manners and prevailing fancies of his countrymen are immortalized in connection with local scenery. Among those almost every variety of disposition finds its favourite. The quiet households of the kingdom have received a sort of apotheosis in the "Cottar's Saturday Night." It has been objected that the subject does not afford scope for the more daring forms of the author's genius; but had he written no other poem, this heartful rendering of a good week's close in a God-fearing home, sincerely devout, and yet relieved from all suspicion of sermonizing by its humorous touches, would have secured a permanent place in our literature. It transcends Thomson and Beattie at their best, and will smell sweet like the actions of the just for generations to come. Lovers of rustic festivity may agree with Professor Craik in holding that the poet's greatest performance is his narrative of "Halloween," which for easy vigour, fulness of rollicking life, blended truth and fancy, is unsurpassed in its kind. Campbell, Wilson, Hazlitt, Montgomery, Burns himself, and the majority of his critics, have recorded their preference for "Tam 'O Shanter," where the weird superstitious element that has played so great a part in the imaginative work of this part of our island is brought more prominently forward. Few passages of description are finer than that of the roaring Doon and Alloway Kirk glimmering through the groaning trees; but the unique excellence of the piece consists in its variety, and a perfectly original combination of the terrible and the ludicrous. Like Goethe's *Walpurgis Nacht*, brought into closer contact with real life, it stretches from the drunken humours of Christopher Sly to a world of fantasies almost as brilliant as those of the *Midsummer Night's Dream*, half solemnized by the severer atmosphere of a sterner clime. The contrast between the lines "Kings may be blest," &c., and those which follow, beginning "But pleasures are like poppies spread," is typical of the perpetual antithesis of the author's thought and life, in which, at the back of every revelry, he sees the shadow of a warning hand, and reads on the wall the writing, *Omnia mutantur*. With equal or greater confidence other judges have pronounced Burns's masterpiece to be "The Jolly Beggars." Certainly no other single production so illustrates his power of exalting what is insignificant, glorifying what is mean, and elevating the lowest details by the force of his genius. "The form of the piece," says Mr Carlyle, "is a mere cantata, the theme the half-drunken snatches of a joyous band of vagabonds, while the grey leaves are floating on the gusts of the wind in the autumn of the year. But the whole is compacted, refined, and poured forth in one flood of liquid harmony. It is light, airy, and soft of movement, yet sharp and precise in its details; every face is a portrait, and the whole a group in clear photography. The blanket of the night is drawn aside; in full ruddy gleaming light these rough tatterdemalions are seen at their boisterous revel wringing from Fate another hour of wassail and good cheer." Over the whole is flung a half-humorous, half-savage satire—aimed, like a two-edged sword, at the laws and the law-breakers, in the acme of which the graceless crew are raised above the level of ordinary gipsies, footpads,

and rogues, and are made to sit "on the hills like gods together, careless of mankind," and to launch their Titan thunders of rebellion against the world.

> "A fig for those by law protected;
> Liberty 's a glorious feast;
> Courts for cowards were erected,
> Churches built to please the priest."

A similar mixture of drollery and defiance appears in the justly-celebrated "Address to the Deil," which, mainly whimsical, is relieved by touches of pathos curiously quaint. "The effect of contrast," it has been observed, "was never more happily displayed than in the conception of such a being straying in lonely places and loitering among trees, or in the familiarity with which the poet lectures so awful a personage,"—we may add, than in the inimitable outbreak, anticipatory of Professor Maurice, at the close—

> "O would you tak a thought an' men'."

Mr Carlyle, in reference to this passage, cannot resist the suggestion of a parallel from Sterne. "He is the father of curses and lies, said Dr Slop, and is cursed and damned already. I am sorry for it, quoth my Uncle Toby."

Burns fared ill at the hands of those who were not sorry for it, and who repeated with glib complacency every terrible belief of the system in which they had been trained. The most scathing of his *Satires*, under which head fall many of his minor and frequent passages in his major pieces, are directed against the false pride of birth, and what he conceived to be the false pretences of religion. The apologue of "Death and Dr Hornbook," "The Ordination," the song "No churchman am I for to rail and to write," the "Address to the Unco Guid," "Holy Willie," and above all "The Holy Fair," with its savage caricature of an ignorant ranter of the time called Moodie, and others of like stamp, not unnaturally provoked offence. As regards the poet's attitude towards some phases of Calvinism prevalent during his life, it has to be remarked that from the days of Dunbar till now there has been a degree of antagonism between Scotch verse and the more rigid forms of Scotch theology.

It must be admitted that in protesting against hypocrisy he has occasionally been led beyond the limits prescribed by good taste. He is at times abusive of those who differ from him. This, with other offences against decorum, which here and there disfigure his pages, can only be condoned by an appeal to the general tone of his writing, which is reverential. Burns had a firm faith in a Supreme Being, not as a vague mysterious Power, but as the Arbiter of human life. Amid the vicissitudes of his career he responds to the cottar's summons, "Let us worship God."

> "An atheist's laugh 's a poor exchange
> For Deity offended"

is the moral of all his verse, which treats seriously of religious matters. His prayers in rhyme give him a high place among secular Psalmists.

Like Chaucer, Burns was a great moralist, though a rough one. In the moments of his most intense revolt against conventional prejudice and sanctimonious affectation, he is faithful to the great laws which underlie change, loyal in his veneration for the cardinal virtues—Truth, Justice, and Charity,—and consistent in the warnings, to which his experience gives an unhappy force, against transgressions of Temperance. In the "Epistle to a Young Friend," the shrewdest advice is blended with exhortations appealing to the highest motive, that which transcends the calculation of consequences, and bids us walk in the straight path from the feeling of personal honour, and "for the glorious privilege of being independent." Burns, like Dante, "loved well because he hated, hated wickedness that hinders loving," and this feeling, as in the lines—"Dweller in yon dungeon dark," sometimes breaks bounds; but his calmer moods are better represented by the well-known passages in the "Epistle to Davie," in which he preaches acquiescence in our lot, and a cheerful acceptance of our duties in the sphere where we are placed. This *philosophie douce*, never better sung by Horace, is the prevailing refrain of our author's *Songs*. On these there are few words to add to the acclaim of a century. They have passed into the air we breathe; they are so real that they seem things rather than words, or, nearer still, living beings. They have taken all hearts, because they are the breath of his own; not polished cadences, but utterances as direct as laughter or tears. Since Sappho loved and sung, there has been no such national lyrist as Burns. Fine ballads, mostly anonymous, existed in Scotland previous to his time; and shortly before a few authors had produced a few songs equal to some of his best. Such are Alexander Ross's "Wooed and married," Lowe's "Mary's Dream," "Auld Robin Gray," "The Land o' the Leal," and the two versions of "The Flowers o' the Forest." From these and many of the older pieces in Ramsay's collection, Burns admits to have derived copious suggestions and impulses. He fed on the past literature of his country as Chaucer on the old fields of English thought, and—

> "Still the elements o' sang,
> In formless jumble, right and wrang,
> Went floating in his brain."

But he gave more than he received; he brought forth an hundred-fold; he summed up the stray material of the past, and added so much of his own that one of the most conspicuous features of his lyrical genius is its variety in new paths. Between the first of war songs, composed in a storm on a moor, and the pathos of "Mary in Heaven," he has made every chord in our northern life to vibrate. The distance from "Duncan Gray" to "Auld Lang Syne" is nearly as great as that from Falstaff to Ariel. There is the vehemence of battle, the wail of woe, the march of veterans "red-wat-shod," the smiles of meeting, the tears of parting friends, the gurgle of brown burns, the roar of the wind through pines, the rustle of barley rigs, the thunder on the hill—all Scotland is in his verse. Let who will make her laws, Burns has made the songs, which her emigrants recall "by the long wash of Australasian seas," in which maidens are wooed, by which mothers lull their infants, which return "through open casements unto dying ears"—they are the links, the watchwords, the masonic symbols of our race.

In his "Vision" the poet imagines his Muse (probably as real to him as to Homer) descending to address her votary beside the plough. After paying through her lips a generous tribute to his predecessors, he draws, as usual, a lesson from his own career, "by passion driven." The goddess counsels him to "preserve the dignity of man" and "trust the universal plan," and leaving a wreath of green holly to deck his brows, passes "in light away."

The poet passed away in darkness, but his name will never disappear from our literature. He stands before us as a feature of Nature; and the fact that he cannot be moved from the hearts of his countrymen, that they recognize and respect a man who has refused to mutilate human nature, and who at once celebrates and strives to harmonize its ethnical and Christian elements, marks a gulf still fixed between Scotland and the Spain with which Mr Buckle has associated it. "The generous verse of Burns," says Dr Craik, "springs out of the iron-bound Calvinism of the land like flowing water from Horeb's rock."

The first edition of Burns's *Poems* was published at Kilmarnock in 1 vol. 8vo, in 1786; the second edition was published in Edinburgh in 1787 (2 vols. 8vo); the third edition appeared at Dumfries in

1793. After the poet's death Dr Currie of Liverpool issued a collected edition of his works, with a Life, for the benefit of his widow and family (4 vols. 8vo, Lond. 1800). This included letters as well as poems, but was far from being complete. The edition of Allan Cunningham (8 vols. 8vo. Lond. 1834) contains a large number of pieces that are not to be found in Currie's edition. *The Life and Works of Burns*, by Dr Robert Chambers (Edin. 1851–2), has the distinctive feature that the poems are arranged in chronological order, and interwoven with the narrative of the poet's life, which is, perhaps, the fullest and most precise in its details that has appeared. The *Kilmarnock Popular Edition* (2 vols. Kilmarnock, 1871) possesses special interest from the fact that the first volume contains an exact reprint, with fac-simile title-page, of the original edition of 1786. It deserves notice that within a year of the publication of the first Edinburgh edition, two separate editions of the poems were issued in America, at New York and Philadelphia, 1788.

The *Life of Burns*, by J. Gibson Lockhart (1828), has passed through several editions. Among the numerous critical estimates of the poet the foremost place is given by universal consent to the essay of Carlyle, which first appeared in the *Edinburgh Review* (1828), and is reprinted among his miscellaneous essays. (J. N.)

BURNTISLAND, a parliamentary burgh and seaport of Scotland, in the county of Fife. It possesses a good pier, a dry dock, and a commodious harbour. Distilling and the herring-fishery are carried on, and a good deal of coal and pig-iron is exported. It is the northern station of the ferry across the Firth of Forth in connection with the North British Railway from Granton, from which it is about five miles distant. The burgh unites with Kirkcaldy, Kinghorn, and Dysart in sending one member to Parliament. The population in 1871 was 3422.

BURSLEM, a town of England, in the county of Staffordshire, 18 miles south of Macclesfield, and 150 miles from London. It stands on a gentle eminence near the Trent and Mersey canal, and is the principal town of the potteries' district. It contains a town-hall, erected in 1865, a market-house, a news-room, and a mechanics' institute; but its most interesting building is the Wedgwood Institute, founded in 1863 in honour of the great manufacturer, who was born in the town in 1730. It comprises a school of art, a free library, and a museum; and the exterior is richly and peculiarly ornamented, to show the progress of fictile art. The tower of the parish church is of some antiquity, though the building itself is of modern date. The town is mentioned in Domesday Book as *Barcardeslim*, and it appears at an early period as a seat of the pottery trade. Its prosperity was greatly increased in the end of the 18th century by the opening of the Grand Trunk canal. Population of township in 1872, 20,971.

BURTON, Robert (1576–1640), author of the *Anatomy of Melancholy*, was born at Lindley, Leicestershire, on the 8th February 1576. He attended the grammar schools of Nuneaton and Sutton Coldfields, and at the age of seventeen entered Brasenose College, Oxford. In 1599 he was elected student of Christ Church, and in 1614 took the degree of B.D. In 1616 he was presented to the vicarage of St Thomas, and in 1636 to the rectory of Segrave. He died on the 25th January 1639–40. *The Anatomy of Melancholy, what it is, with all the kinds, causes, symptoms, prognostics, and several cures of it: In three partitions, with their several sections, members, and sub-sections, philosophically, medicinally, historically opened and cut up: By Democritus Junior, with a satyrical preface conducing to the following discourse*, was published in 1621. Our information with regard to the strange author of this strange book is very scanty. Anthony Wood's account of him has often been quoted; it represents what must have been his contemporaries' opinion of him. A very curious anecdote is told of the method he adopted to dissipate the morbid melancholy which weighed upon him. He used to go to the bridge foot and hear the ribaldry of the bargemen, which rarely failed to throw him into a violent fit of laughter. His book is truly a marvellous production, and proves at least one thing, that the author was a thorough classical scholar. Indeed the work is a cento of quotations, and, like the *Intellectual System* of Cudworth, has served as a storehouse of learned material. Sterne is not the only one who has borrowed from the author of the *Anatomy*. The book itself is essentially unsystematic, but has a fine flavour of thorough-going ill-humour about it. This world was a dreary farce, and life was something to be laughed at. With a certain class of readers it has always been a favourite. Charles Lamb is a typical instance of a reader in Burton. The introductory poem has some curious analogies of style and thought to the *Allegro* and *Penseroso* of Milton.

BURTON-ON-TRENT, an English town, in the north-east part of the hundred of Offlow, and the eastern division of the county of Stafford. It is situated on the west bank of the River Trent, and is distant from Stafford 25 miles, from Derby 11 miles, and about 126 miles from London. The parish comprises over 9625 acres, and is divided into the townships of Burton-on-Trent, Burton Extra, Branston, Horninglow, and Stretton on the Staffordshire side of the river, and Stapenhill and Winshill on the Derbyshire side.

The history of the town may be said to begin with the erection of a church or monastery by the river side towards the close of the 9th century. But from that time we learn little concerning the place or its progress for about a hundred years. In 1002, the Burton abbey was founded by Wulfric, earl of Mercia, and substantially endowed. In 1540 it was surrendered to Henry VIII., who, in 1549, made a grant of it with all its lands and properties to his secretary Sir William Paget, the ancestor of the present lord of the manor, the marquis of Anglesey. In the time preceding the foundation of the abbey, the importance of the town was probably equal to that of the majority of Saxon boroughs, but it seems subsequently to have made but little progress, and even to the close of the 16th century to have had its character and condition mainly determined by the fact of its being the centre of an important ecclesiastical district. Notwithstanding the situation of the town being such as to have made it always the key to one of the great high roads between the Midland Counties, it does not seem to have been at any time fortified. It was the scene, however, of many frays. Especially notable is the battle which was fought at the Old Bridge on the 18th of March 1321, between the forces of Edward II. and Thomas earl of Lancaster, in which the latter was defeated.

During the civil war of the 17th century, Burton was repeatedly taken and re-taken. The consequences to the town were serious, entailing permanent injury to its interests in trade. Previous to the outbreak of the war the woollen trade had been the staple of the town, although it had also long been noted for its alabaster works, but the frequent plunderings of that unquiet time all but ruined these industries.

In the year 1255 the greater part of the town was destroyed by fire, and in 1514 it was nearly swept away by floods. The latter form of disaster has frequently recurred. In 1771, in 1792, in 1795, in 1852, and twice in 1875 the town was visited by heavy floods, which inundated the greater part of it, and inflicted considerable damage. In 1875 the depth of water in several streets was from 4 to 5 feet, and the current strong and dangerous.

In the year 1698 an Act of Parliament was obtained for making the Trent navigable as far as Burton, and for many years the "Burton Boat Company," as it was called, did good service as carrying-agents for the trade of the town. The opening of the Midland Railway in August 1839 was followed by results more marked even than such as have commonly attended the introduction of railways. The progress of the town since that date has been constant and

for the last twenty years remarkably and increasingly rapid.

During the earlier years of the present century the cotton mills of Burton were so extensive as to give employment to several hundred hands, but since 1849 the cotton trade has been discontinued. The demands of the brewing trade of late years, both as regards space and labour, seem to have made it difficult for any competing industry to exist. At any rate it must be admitted that at the present time the town derives all its commercial prosperity from the manufacture of ale, the recognized superiority of which is in a great measure due to the fact that the water used in its production, and obtained from wells sunk in the neighbourhood of the breweries, is impregnated with sulphate of lime derived from the gypseous deposits of the district. The brewing trade of Burton is comparatively of recent development, although the brewing of superior ale within the town was undoubtedly known as one of the features of the place in the days when the abbey flourished. The trade, as distinguished from private brewing, is reckoned to have commenced about the year 1708, and forty years later it had so extended as to have found a market at St Petersburg and the Baltic ports. In the year 1796, so flourishing had the trade become that there were then in the town no fewer than nine brewing firms. That most famous of Burton ale products known as "India Pale," or "Bitter Beer," was first manufactured, as a beverage suited to the climate of the East, about the year 1823, and for some years India was its only market. The favour it has since obtained at home it owes to accident. A vessel carrying some hogsheads of India pale ale was lost in the channel, and its cargo sold for the benefit of the underwriters. In this way it was that bitter beer first became known as a beverage in this country, and so rapid was its popularity, that since 1828 the pale ale trade has taken the lead in the commercial transactions of the town. The development of the Burton brewing trade generally from that date to the present time has been marvellous, but especially so since 1862 The magnitude which it has now attained may be inferred from the following facts and statistics. There are in all some thirty breweries in the town, the largest of which are those of Messrs Bass & Co. and of Samuel Allsopp & Sons. Last year (1875) the quantity of malt mashed in the several breweries together was 737,190 quarters, to contain which in the form of ale would require 2,948,761 barrels of 36 gallons each. The average price per barrel being 48s., we are enabled to set down the amount of brewing business done in the town, in one year alone, at £7,000,000. A calculation has been made by which it has been found that if all the barrels (2,948,761) of ale brewed in twelve months were put end to end in a straight line, that line would measure no less than 1535 miles. The Messrs Bass & Co. alone brew 250,000 quarters per annum; S. Allsopp & Sons alone 200,000 quarters. The business premises of the former firm cover 50 acres of freehold and 100 acres of leasehold property. Traversing these premises they have six miles of railway and six locomotives their own exclusive property. They employ over 2000 men and boys, and pay in wages to employés in Burton alone about £2000 per week. S. Allsopp & Sons have also private lines of railway, extending over 10 miles. These lines, Allsopp's and Bass's and others, as they connect with the outer railway system, intersect the town at many points. The amount paid to the several railway companies (Midland, North Staffordshire, and London and North Western) by the several brewing firms for carriage of ale in the course of 1875 for that year alone was £517,665.

The sanitary conditions of the town has been greatly improved since the passing of "Burton-upon-Trent Act, 1853." Under this Act, the town is divided into three wards, the Burton-upon-Trent Ward, the Burton Extra Ward, and the Horninglow Ward; and the local government is vested in a board of commissioners, twenty-seven in number, elected by the wards. Of public works in Burton the most notable is the New Bridge over the Trent, which was erected at a cost of £20,000, and was opened for traffic on the 22d June 1864. It is 469 yards in length, and has twenty-nine arches, supported by light but solid buttresses. The old bridge, which this one superseded, was of a curved form and extremely narrow. It had thirty-four arches, and is said to have been the longest bridge in the kingdom. The new cemetery, which occupies a plot of land 12 acres in extent, is situated in the township of Stagenhill, and was constructed at a cost of £13,000. It is divided into three parts, devoted to the separate burial of members of the Church of England, of nonconforming churches, and of the Church of Rome. It contains two mortuary chapels, and the house of the registrar.

Although, in some old records, Burton is styled a borough, it is certain it was not possessed of a charter of incorporation, nor has it yet obtained one. The police are those of the county. About five years ago the Burton Infirmary was opened, and has since been considerably enlarged. A new post-office is being erected, of dimensions suitable to the increasing growth of the town. There are three local newspapers published weekly. On the Derbyshire side of the river, and skirting its bank is the public recreation ground. The principal banking firm is the "Burton, Uttoxeter, and Ashbourne Union Bank," established 1839.

Burton is included in the diocese of Lichfield. Besides the Church of England, which has seven places of worship, there are the following denominations represented,—Presbyterian, Congregational, Wesleyan, Baptist, Free Church Methodist, Primitive Methodist, and Roman Catholic. The educational interests of the town are well cared for, there being, besides board schools, a grammar school, an endowed school, and three other schools of a voluntary character.

Commensurate with the increase of trade has been the increase of population. In 1801, when the first census was taken, it was a very little over 6000. From that year onwards to 1851 it steadily but very gradually increased. The ten years ending 1861 show the first great advance, the population being then 17,358. In 1871 it had grown to 23,748, and as the increase since then has been at the rate of over 1000 per annum, the population cannot now (1876) be less than 30,000.

BURTSCHEID, or Borcette, a town of Prussia, in the government of Aix-la-Chapelle (Aachen), and immediately to the S.E. of that city, with which it is connected by lines of houses. It occupies the slopes of a hill on the Wormfluss, and, like Aix-la-chapelle, is famous for its mineral springs. One of these, known as the Mill-bath spring, is the hottest of Central Europe, having a temperature of 155° Fahr. The water is employed both externally and internally, and the establishments for its use are extensive and convenient. The town carries on the manufacture of woollen yarn and cloth, cast-iron goods, and machinery, and possesses an important trade. Burtscheid grew up round a Benedictine monastery, founded probably in the 10th century by Gregory, son of the Greek emperor Nicephorus Phocas, and brother-in-law of Otto II. of Germany, and is said to have taken its name of *Porcetum* from the number of wild swine in the neighbourhood. In the 13th century the Benedictines became defunct, and a number of nuns from the convent of St Salvatorberg, near Aix-la-Chapelle, entered into possession. Their establishment continued till 1802, when it was broken up by the French. Population in 1872, 10,081.

BURU, Boero, or Bouro, an island of the East Indian Archipelago, belonging to the residency of Amboyna, and

situated about 250 miles E. of Celebes. According to Melvill von Carnbée it has an area of 3487 square miles, and extends from 3° 18′ to 3° 50′ S. lat. Its surface is for the most part very mountainous, though the seaboard district is frequently alluvial and marshy from the deposits of the numerous rivers by which the island is traversed. Of these, estimated at no less than 125, comparatively few are navigable except the Kayeli or Wai Apoe, which is the largest of all. The principal peaks are the Tomahoe (Kapâla-Lemadang, Saniane or Buru-dome), 8529 feet in height, the Filehet, and the Palamatta. In the middle of the western portion of the island lies the large lake of Wakaholo, with a circumference of 37 miles, and a depth of about 100 feet. By far the larger part of the country is covered with natural forest and prairie land, but such portions as have been brought into cultivation are highly fertile. Coffee, rice, and a variety of fruits, such as the lemon, orange, banana, pine-apple, and cocoa-nut are readily grown, as well as sago, red-pepper, tobacco, and cotton. The only important export, however, is cajeput oil, a sudorific distilled from the leaves of the *Melaleuca Cajuputi*, or white-wood tree, of which about 8000 bottles are manufactured annually and sent to Java and other parts of the archipelago. The native flora is very rich, and the teak, ebony, and canari trees are especially abundant. Among the animals are buffaloes, hogs, deer, crocodiles, lizards, and snakes; and ducks, doves, cockatoos, and birds of paradise are the chief representatives of the feathered species. According to Mr Wallace, the inhabitants are mainly of two partially amalgamated races—Malays on the sea-coast like those of Celebes, and Alfuros in the interior akin to those in Ceram. The latter are still completely pagan, live in scattered hamlets, and have come very little in contact with any civilization. Among the maritime population a small number of Chinese, Arabs, and other races are also to be found. The island is divided by the Dutch into the regencies of Kayeli, Ilat, Lumaëteh, Waaisama, Massareteh, Foggi, Bara, Licella, Talisa, Marulat, and Leliali. The village of Kayeli is inhabited by eleven Mahometan tribes, who were compelled by Arnold de Vlaming in 1657 to gather together from the different parts of the island, while all the clove-trees were mercilessly exterminated. Before the arrival of the Dutch the islanders were under the dominion of the sultan of Ternate; and it was their rebellion against him that gave the Europeans the opportunity of effecting their subjugation. In 1854 the port of Kayeli was declared free to all nations without customs on either ship or cargo.

See T. J. Willer, *Het eiland Boeroe, zijne exploitatie en Halfoersche Instellingen*, Amsterdam, 1858; Wallace's *Indian Archipelago*; Veth's *Woordenboek van Nederl. Indie.*

BURY, a manufacturing town and parliamentary borough of England, in the county of Lancaster, on the Irwell, 8 miles N.N.W. of Manchester. The woollen-trade, introduced in the 14th century, and of such importance in the reign of Elizabeth that she appointed an officer to stamp the cloth, still gives employment to 1000 of the population, but it has been greatly surpassed in extent by the cotton manufacture, which with its various branches gave employment in 1872 to 16,256 men and women of the age of twenty years or upwards. The auxiliary and supplemental trades of engine-making, spindle-making, calico-printing, bleaching, and dyeing are also largely carried on; the paper manufacture employs about 600 people; upwards of 1000 miners find work in the neighbouring coal-pits; 1200 workmen are engaged in the iron manufacture, and nearly 200 in the stone quarries. The town has been not only greatly extended but also greatly improved since the middle of the century; it is well drained, and has a good supply of water. It contains a town-hall, an athenæum (including a museum), a free grammar school, founded by the Rev. Roger Kay, a mechanics' institute, and several public libraries. The parish church of St Mary's was rebuilt in 1776. The government, which was at one time in the hands of three constables, appointed by the earl of Derby, the lord of the manor, was afterwards entrusted to a board of commissioners under a local Act; but the town has applied for municipal incorporation. Bury is a place of considerable antiquity, and was formerly the seat of a baronial castle, which was destroyed by the Parliamentary forces in 1644. Sir Robert Peel was born at Chamber Hall in the neighbourhood, and his father did much for the prosperity of the town by the establishment of extensive printworks. A monument to the statesman now adorns the market-place. The parliamentary borough, which comprises the townships of Bury and Elton, has returned one member to Parliament since the Reform Bill of 1832. Its population in 1871 was 41,344, of whom 19,849 were males, and 21,495 females; the inhabited houses numbered 8279, and the registered electors 5518.

BURY, RICHARD DE. See AUNGERVYLE, vol. iii. p. 85.

BURY ST EDMUNDS, a market-town and municipal and parliamentary borough of England, in the county of Suffolk, on the Lark, 26 miles N.W. of Ipswich, and 71 miles from London. It is governed by a mayor, six aldermen, and eighteen councillors, and returns two members to Parliament. The town is pleasantly situated on a gentle eminence, in a fertile and richly cultivated district, is clean and well built, and has a good drainage system. It is supposed to be the *Villa Faustini* of the Romans, and numerous Roman remains have been dug up on the spot. It was the Beodericsworth of the Saxons, and by them was made a royal town of East Anglia. Its present name is derived from St Edmund, the king and martyr, who was taken prisoner and put to death by the Danes in 870. In 1020 a monastery was founded there by Canute, which for magnificence and splendour surpassed every other establishment of the kind in Britain, with the exception of that of Glastonbury. It was 505 feet long and 212 wide, and contained twelve chapels. The abbot had a seat in Parliament, with the power to inflict capital punishment, and judged in all civil causes within the liberty. The privilege of coining was granted to the abbot by Edward the Confessor, and both Edward I. and Edward II. had mints in the town. In 1327 the people of the town and neighbourhood attacked the monastery and reduced a large part of it to ashes. The tower or church-gate, one of the finest specimens of Norman architecture in the kingdom, and the western gate, erected about the middle of the 14th century, with a small portion of the walls, are all that now remains of that magnificent structure. St Mary's church, a fine Gothic edifice, with a beautifully carved roof, was erected in the earlier part of the 15th century, and contains the tomb of Mary Tudor, Queen of Louis XII. of France. St James's church is also a very fine building, containing several handsome monuments. The free grammar school, founded by Edward VI., has two scholarships at Cambridge, and six exhibitions to each university. The town has a shire-hall where assizes for the county and liberty are held, a handsome and commodious corn exchange, a guildhall, news and assembly rooms, a theatre, a savings-bank, botanic gardens, a county jail, a general hospital, and about 100 almshouses. The market-days are Wednesday and Saturday. Wednesday's market is very important, both for corn and cattle, but particularly for the latter, being second only to that of Norwich, which is the largest in the Eastern counties. About a mile below the town the river becomes navigable for barges to Lynn, whence coals and other commodities were formerly brought, but of late years, since the formation of the railway, the river has been but little used.

There are four lines of railway,—in connection with London and Cambridgeshire for the north, Thetford to Norwich and West Norfolk, Ipswich and East Suffolk, and Colchester for Essex. In the vicinity is Ickworth, the magnificent seat of the marquis of Bristol. The town was the birthplace of Bishop Gardiner, and gives the title of viscount to the Keppel family (Earls of Albemarle). Population in 1871, 14,928.

BUSBECQ, AUGIER GHISLEN DE (1522–1592), a Flemish diplomatist and traveller, was born at Commines in 1522, and was educated at the universities of Louvain, Paris, Venice, Bologna, and Padua. He was engaged in several important employments and negotiations, and in particular was twice sent as ambassador by the Emperor Ferdinand I. to the court of Soliman II. He made a collection of curious inscriptions and manuscripts; and in his second journey to Constantinople he carried with him an artist to make drawings of the rarest plants and animals. In 1562 he returned to Vienna, and was appointed tutor to the sons of the Emperor Maximilian II. Busbecq died at St Germain, near Rouen, October 28, 1592. He wrote a *Discourse of the State of the Ottoman Empire*, and a *Relation of his Two Journeys to Turkey*. A translation of the Travels in Turkey was published in Glasgow by Robert Urie in 1761.

BUSBY, RICHARD (1606–1695), D.C.L., head-master of Westminster school, was born at Lutton in Lincolnshire in 1606. He was educated at the school which he afterwards superintended for so long a period, and first signalized himself by gaining a king's scholarship. From Westminster he removed to Christ Church College, Oxford, where he graduated in 1628. In his thirty-third year he had already become renowned for the obstinate zeal with which he supported the falling dynasty of the Stuarts, and was rewarded for his services with the prebend and rectory of Cudworth, with the chapel of Knowle annexed, in Somersetshire. Next year he became head-master of Westminster school. His reputation as a teacher soon became so great that many of the noblest families entrusted their children to his care. He himself once boasted that sixteen of the bishops who then occupied the bench had been birched with his "little rod." No school in England has on the whole produced so many eminent men as Westminster did under the régime of Busby. Among the more illustrious of his pupils may be mentioned South, Dryden, Locke, Prior, and Bishop Atterbury. He wrote and edited many works for the use of his scholars. His original treatises (the best of which are his Greek and Latin grammars), as well as those which he edited, have, however, long since fallen into disuse. Busby died in 1695, in his ninetieth year, and was buried in Westminster Abbey, where his effigy is still to be seen.

BUSCA, a town of Italy, in the province of Cuneo, 9 miles from the city of that name, on the left bank of the Macra, a confluent of the Po. It contains a college, a hospital, and two botanic gardens. The inhabitants are engaged in the culture of the silkworm and the manufacture of leather and ironwares; and there are marble and alabaster quarries. It is the site of some Roman antiquities. Population, 9533.

sensible of the defective state of geographical science, and resolved to devote his life to its improvement. Withdrawing as soon as possible from the count's family, he went to reside at Copenhagen, and devoted himself entirely to this new pursuit. In 1752 he published a *Description of the Counties of Schleswig and Holstein*, a work that was much approved. In 1754 he removed to Göttingen, and married Christiana Dilthey, a young lady of some temporary reputation as a poetess. Here a work in which he dissented from some of the Lutheran tenets lost him the appointment in 1757 to the theological chair, for which he had become a candidate. Two years later he was appointed professor of philosophy; but in 1761 he accepted an invitation to the German congregation at St Petersburg. There he organized a school, which, under his auspices, soon became one of the most flourishing in the North of Europe, but a disagreement with Marshal Munich led him, in spite of the empress's offers of high advancement, to return to Germany in 1765. He first went to live at Altona; but next year he was called to superintend an extensive educational establishment, known as the Greyfriars Gymnasium (*Gymnasium zum Grauen Kloster*), which had been formed at Berlin by Frederick the Great. Here he superintended the progress of every pupil, and inspected the minutest details connected with the prosperity of the institution, besides giving lectures on the history of the arts and sciences. He continued to prosecute his various labours till a dropsy, under which he had long suffered, terminated his life on the 28th May 1793. His writings and example gave a new impulse to education throughout Prussia, and the Government was so sensible of the value of his services that they allowed his extensive correspondence to pass free of postage.

Few authors, even in Germany, have been more prolific than Büsching. As enumerated by Meusel in his *Lexicon of German Authors*, his works amount to more than a hundred. They may be classed under the heads of Geography and History, Education, Religion, and Biography. The first class comprehends those upon which his fame chiefly rests; for although he did not possess the geographical genius of D'Anville, he may be regarded as the creator of modern Statistics. His *magnum opus* is the *Neue Erdbeschreibung*, (*New Description of the Globe*). The first four parts, which comprehend Europe, were published in four volumes (1754–1761), and have been translated into many of the European languages. They appeared in English with a preface by Murdoch, in six volumes 4to, London, 1762. In 1768 the fifth part was published, being the first volume upon Asia, containing Asiatic Turkey and Arabia. It displays an immense extent of research, and is generally considered as his masterpiece. Büsching was also the editor of a valuable collection entitled *Magazin für Historie und Geographie*, 2 vols. 4to, 1767–93; also of *Wochentl. Nachrichten von neuen Landkarten*, Berlin, 1773–87.

His elementary works on education long held a distinguished place in this branch of literature, but his theological writings are not much esteemed. In biography he wrote a number of articles for the above mentioned *Magazin*, and a valuable collection of *Beiträge zur Lebensgeschichte merkwürdiger Personen*, 6 vols. 1783–9, including a very elaborate life of Frederick the Great.

BUSHIRE, or ABUSCHEHR, a town of Persia, in the province of Fars, situated in the Persian Gulf. The surrounding country is a parched and barren desert, consisting of brown sand or grey clay and rock, unenlivened by any kind of vegetation. The town, which is of a triangular form, occupies the extremity of a peninsula eleven miles long and four broad, and is encircled by the sea on all sides except the south. It is fortified on the land side by a mud wall with round towers. The houses being mostly built of white stone gives the city, when viewed from a distance, a rather clean and handsome appearance, but on closer inspection the streets are found to be narrow, irregular, ill-paved, and filthy. Almost the only handsome buildings are the sheikh's palace and the British residency. Ships of 300 tons are obliged to lie in the roads six miles from the town. The water immediately east of the town

is deep, but its navigation is impeded by a bar, which can only be passed by vessels drawing not more than 8 or 9 feet of water, except at spring-tides, when there is a rise of from 8 or 10 feet. Bushire carries on a considerable trade. particularly with Calcutta, Bombay, and Java. Its imports are indigo, sugar, rice, spices, steel, cotton and woollen goods, coffee, &c.; and its principal exports are raw silk, opium, Kerman wool, shawls, silk goods. carpets, horses, dried fruits, wine, grain, copper, turquoises, pearls, asafœtida, and gall-nuts. The climate is excessively hot particularly in the months of June, July, and August. The water is very bad; that fit for drinking requires to be brought in goat-skins from wells, distant 1½ mile from the city walls. The population is variously estimated at from 10,000 to 20,000.

The importance of Bushire has much increased of late years. It is now not only the headquarters of the English naval squadron in the Persian Gulf, and the land terminus of the Indo-European line of telegraph, but it also forms the chief station in these seas of the British Indian Steam Navigation Company, which runs its vessels weekly between Bombay and Bussorah, and it is further expected that, if our Foreign Jurisdiction Act should be applied to Persia, an appellate court will be formed at Bushire. In the meantime several European mercantile houses have been established in the town, and there can be no doubt that if the means of communication with the interior were improved, trade would rapidly increase. Notwithstanding, indeed, the drawbacks of bad roads, insufficient means of transport (wheeled carriages being unknown and beasts of burthen being few and dear), want of security, and illegal exactions, the annual value of the Bushire trade is now estimated at £600,000, of which one-quarter represents the exports and three-quarters the imports, the balance of trade against Persia at this single port thus amounting to about £300,000 a year, which is met by a constant drain of the precious metals to India. During the late war with Persia (1856–57) Bushire surrendered to a British force, and remained in our occupation for some months. The town yields a yearly revenue of about £15,000, mainly derived from customs, and is the chief place of a district, extending for 300 miles along the sea-coast from Dilem to Congoon, which is assessed in the Shiráz register at about £25,000 per annum. At Ríshire, in the vicinity of Bushire, there are extensive ruins, among which bricks stamped with cuneiform legends have been found, showing that the place was a very old Elamite settlement under the kings of Susa. It continued also to flourish under the name of Rív-Ardeshír, during the Sassanian period, and only fell into decay after the Arab conquest, its place as the great emporium of trade being successively taken by Siráf (the modern Táhiri), Keis, and Ormuz. The British commercial factory was transferred from Gombroon (modern Bander Abbáss) to Bushire during the last century; but the duties of the Bushire resident at present are exclusively political. (H. C. R.)

BUSHMEN, or Bosjesmans, so named by the British and Dutch colonists of the Cape, but calling themselves *Saab* or *Saan*, are an aboriginal race of South Africa, allied in some respects to the Hottentots, but differing from them in several essential points, and along with these having nothing whatever in common with the Kaffre or the Negro. The area in which they are found in nomadic families may be described as extending from the inner ranges of the mountains of Cape Colony, through the central Kalahari desert to near Lake Ngami, and thence north-westward to the districts about the Ovámbo River north of Damara Land, in about 18° S. lat., or only over the most barren portions of the South African deserts, into which they have been pressed by the encroachments of the Kaffre, Hottentots, and Europeans, a few also remaining in the most inaccessible clefts of the Drakenberg range about the sources of the Vaal. They rank with the savages of Australia as the lowest existing type of mankind, human nature being nowhere seen in a more destitute or degraded condition. The Bushmen with whom the colonists of the south have come most in contact are of very small stature, of a dirty yellow colour, and generally repulsive countenance. In type they somewhat resemble the Mongolians; the cheek-bones are large and prominent, the eyes deeply set and crafty in expression, the nose small and depressed; the hair appears in small woolly tufts with spaces between. Among 150 of their number measured by the traveller Barrow, the tallest man was 4 feet 9 inches, the tallest woman 4 feet 4 inches. A hollowed back and protruding stomach, with thick hinder parts and small limbs, are frequent characteristics of their figure, but many of them are well-proportioned, all being active and capable of enduring great privations and fatigue. Northward the Bushmen appear to improve both in general condition and in stature. Those met with towards Lake Ngami by Dr Livingstone are described by him as differing from those of the thirsty plains of the Kalahari, being of darker colour and of good proportions; some of those seen by the traveller Baines in this region are also noticed as being taller, some 5 feet 6 inches in height. Their clothing consists of a mantle of skins, termed a *kaross*; but they are fond of ornament, and decorate the arms and legs with beads and iron or copper rings, and the women sometimes stain their faces with red colour. For dwellings in the plains they have low huts formed of reed mats, or may simply occupy a hole in the earth; in the mountain districts they make a shelter among the rocks by hanging mats on the windward side. They do not possess cattle, and have no animals of any sort excepting a few half-wild dogs, nor have they the smallest rudiments of agriculture. Living by hunting, they are thoroughly acquainted with the habits and movements of every kind of wild animals, following the antelope herds in their migrations. Their weapon is a small bow, strung with twisted sinew, used with arrows, which are neatly made of a reed with a barbed head of bone, sometimes tipped with a triangular piece of iron, and always coated with a gummy poisonous compound, which is variously made in different localities. The chief sources of the poison are the milky juice of the *Amaryllis toxicaria*, which is abundant in South Africa, or of the *Euphorbia arborescens*, generally mixed with the venom of snakes or of a large black spider of the genus *Mygale*; or the entrails of a very deadly caterpillar, called N'gwa or 'Kaa, are used alone. From their use of these poisons the Bushmen are held in great dread by the neighbouring races. A rude implement, called the *graaf stock* or digging-stick by the boers,—consisting of a sharpened spike of hardwood over which a stone, ground to a circular form and perforated, is passed and secured by a wedge,—is used by the Bushmen in uprooting the succulent tuberous roots of the several species of creeping plants of the desert. These perforated stones have a special interest in indicating the former extension of the race of the Bushmen, since they are found far beyond the area now occupied by their families.

There does not appear to be the least approach to any tribal unity in the wandering groups of the Bushmen; they have no chiefs, bodily strength alone forming a distinction among them. Their language, which exists in several dialects, is not intelligible to the Hottentots, but has in common with it the nasal, snapping, hissing, or grunting sounds, only used more numerously. The Hottentot language is more agglutinative, the Bushman's more monosyllabic; the former recognizes a gender in names, the latter does not; the Hottentots form the plural by a suffix.

the Bushmen by repetition of the name; the former count up to twenty, the latter can only number two, all above that being "many." The Bushmen possess a remarkable faculty which is not known in any other South African natives, that of graphic illustration; the rocks of the mountains of Cape Colony and of the Drakenberg have everywhere examples of Bushman drawings of men, women, children, and animals characteristically sketched. Rings, crosses, and other signs drawn in blue pigment on some of the rocks, and believed to be some centuries old, have given rise to the speculation that these may be remains of a hieroglyphic writing; and the discovery of drawings of men and women, with antelope heads, in the recesses of the Drakenberg in 1873 (Orpen in *Cape Monthly Magazine*, July 1874), also very ancient, recalls the mythological figures of Egypt. The Bushmen are not deficient in a certain intelligence, and are valued as servants by the boers, being much more energetic than the Hottentots; of all the South African races they have the greatest aptitude for music and the dance. A regularly planned and wholesale destruction of this race on the borders of the colony in the earlier years, reduced their numbers to a great extent; and though this cruel hunting of the Bushmen has ceased, their children are still captured by the boers as servants. In retaliation, the Bushmen have long been the scourge of the farms on the outer borders of the colonies, making raids on the cattle and driving them off in large numbers. On the western side of the deserts they are generally at enmity with the Koranna Hottentots, but on the eastern border of the Kalahari they have to some extent become tributary to the Bechwana Kaffres. Formerly occupying a much larger area, it appears probable that the Bushmen are the earliest remaining aborigines of South Africa, and that they existed there before the Kaffres, and perhaps also anterior to the Hottentots. The discoveries of the dwarf race of the Akka by Dr Schweinfurth beyond the Upper Nile basin, of the little Bushman-like Obongo on the western equatorial coastland by Du Chaillu, and of the Okota, an undersized people leading a miserable existence in bark huts on a branch of the Ogowé River, by De Compiègne in 1874, point to a former more general distribution of this primitive race.

Barrow's *South Africa*, 1801-3; Burchell's *Travels*, 1822; Livingstone's *Missionary Travels*, 1857; Baines's *Explorations*, 1864; Merensky's *Süd-Afrika*, 1875.

BUSHNELL, Horace, D.D. (1802–1876), an American theologian, was born at Litchfield in Connecticut, in April 1802, and died on the 17th of February 1876. He studied at Yale College, where he graduated in 1827, after which he was for eleven months editor of the *Journal of Commerce*, and then teacher in a school in Norwich (Connecticut). In 1829 he became tutor in Yale College. His first study was law, but in 1831 he resolved to devote himself to theology, and in 1833 he was chosen pastor of the North Congregational Church in Hartford (Connecticut), where he remained twenty-four years. During the remainder of his life he had no settled charge, but he continued to be diligently employed both as a preacher and as an author. He took an active part in the establishment of the university of California, and was asked to become its president. Having determined to value truth more highly than peace or consistency, Bushnell thought, and expressed his conclusions, with such freedom as to bring on himself a charge of false doctrine. In 1849 he published *God in Christ*, with an introductory *Dissertation on Language as related to Thought*, in which, it was said, he expressed heretical views as to the Trinity. He was acquitted by seventeen votes to three, but his influence with his church was such that it withdrew from the "Consociation" by which he had been tried, and thenceforward stood alone, a true "congregational" church, whose minister was amenable to no external authority. Bushnell formally replied by writing *Christ in Theology*, in which he employs the important argument that spiritual facts can only be expressed in approximative and poetical language, and concludes that an adequate dogmatic theology cannot exist. That he did not deny the divinity of Christ he proved in *The Character of Jesus, forbidding his possible classification with Men*. He has also published *Christian Nurture*, (1847); *Sermons for the New Life*, (1858); *Nature and the Supernatural*, (1858); *Christ and his Salvation*, (1864); *Work and Play*, (1864); *The Vicarious Sacrifice, grounded on Principles of Universal Obligation*, (1865); *Moral Uses of Dark Things*, (1868); *Sermon on Living Subjects; Women's Suffrage, the Reform against Nature*, (1869); and *Forgiveness and Law*, (1874).

BUSIRIS, the name of a mythical king of Egypt not found either on the monuments or in the chronological lists, but mentioned by the later Greek writers and mythologists. By Apollodorus he was made the son of Ægyptus, and an Egyptian king, or else the son of Poseidon and Lyssianassa. After Egypt had been afflicted for nine years with famine Phrasius, a seer of Cyprus, arrived in Egypt and announced that the cessation of the famine would not take place until a foreigner was yearly sacrificed to Zeus or Jupiter. Busiris commenced by sacrificing the prophet, and continued the custom by offering a foreigner on the altar of the god. It is here that Busiris enters into the circle of the myths and *parerga* of Heracles, who had arrived in Egypt from Libya, and was seized and bound ready to be killed and offered at the altar of Zeus. Heracles burst the bonds which bound him, and, seizing his club, slew Busiris with his son Amphidamas, and his herald Chalbes. This exploit is often represented on vase paintings, the Egyptian monarch and his companions being represented as negroes. Although some of the Greek writers made Busiris an Egyptian king and a successor of Menes, about the sixtieth of the series, and the builder of Thebes, those better informed by the Egyptians rejected him altogether; they do not even admit that he was the lieutenant of Osiris set over the lands opposite Phœnicia and the Mediterranean, nor do they recognize him as living two centuries after Perseus and later than Heracles. Various esoterical explanations were given of the myth, and the name not found as a king is recognized in that of one or more cities of the same name in Northern Egypt. The legend was unknown both to Homer and to Hesiod, and appears after the Greeks were more intimately acquainted with Egypt, and had seen the wall-paintings, or imperfectly understood the popular tales and traditions of the people, for there is no solid reason to believe that human sacrifices were ever offered in the country.

BUSIRIS, the name of an Egyptian town, the capital of the Busirites nomos, or Busirite nome, called in the hieroglyphs Pa-osiri, or Place of Osiris, the eponymous deity of the place. It is the modern Abusir, and lay, according to Herodotus, in the middle of the Delta. It was supposed to be close to the entrance of the gates of the *Aahlu*, or Elysium, and the nome to be that called in the hieroglyphs Kahebs; and Busiris itself may have been the Egyptian *Tattu*. Close to the town, which lay on the Phatnitish or Pathmitish arm of the Nile, was the pyramid of the king Sahura, the successor of Uskafan, a king of the 4th dynasty; this was called the *Sa-ba*, or pyramid of the "Rising Soul," and some supposed that the name *Pa-sahura*, or "city of Sahura," may have been the origin of the name Busiris instead of *Pa-osiri*. The later Greek authors gave many different versions of the name mixed up with their own mythology, such as that Isis had there interred Busiris in the wooden figure of a cow, and that the place was hence called Bousosiris, or that the goddess had there buried

Osiris, when killed by Typhon, in the body of the same animal enveloped in bandages—legends evidently confused with the burial of the Apis in the Serapeum which lay in the vicinity. The shrine of the goddess Isis was situated in it, and a great annual festival and lamentation of Osiris held there, which appears from an inscription of the temple of Denderah to have taken place on the 14th day of the month Choiak. At the time of the privilege, conferred on the nomes of Egypt by the Emperor Hadrian, of coining the money struck at the time of his visit to that country, and dated in the 11th year of his reign 117 A.D., the Busirite nome issued small bronze pieces on which is the goddess Isis standing holding a cow or goat in one hand and a serpent in the other. Demetrius of Phalerum, the philosopher, exiled by Ptolemy Philadelphus, is said to have died at Busiris 284 B.C., having put an end to his life by the bite of an asp. The city was destroyed by the Emperor Diocletian in the 3d century A.D., but the Copts and Arabs have preserved its name in Bousiri and Abusir. Another village of the same name is supposed to have existed in the Letopolite nome.

Herodotus, ii. 59, 61, 165; Apollodorus, ii. 1, 5; Diodorus, i. 17; Isocrates, *Orat.*, ii.; Hyginus, *Fab.*, ii. 45; Schol. Apollon. Rhod., iv. 18, 96; Gerhard, *Trinkschalen*, 8 s 9; Tochon D'Annecy, *Recherches sur les Médailles des nomes*, p. 190.

BUSSORAH, BASSORA, BALSORA, or BASRA, a celebrated city of Asia, in the government of Baghdad, situated in 47° 34′ E. long., 30° 32′ N. lat., on the western banks of the Shatt-el-Arab. It is about 70 miles from the mouth of that noble stream, which is navigable to the city for ships of 500 tons burden after passing the bar at its mouth; this, however, they can only conveniently do at spring-tides. Bussorah is surrounded by walls, which are kept in a tolerable state of repair. They have five gates, and are at the lowest computation about seven miles in circuit. Two canals, cut from the river, surround the town on either side; and uniting beyond it on the western side, form a complete ditch to the fortifications. The houses are meanly built, partly of sun-dried and partly of burnt bricks, with flat roofs surrounded by a parapet; and the bazaars, though stocked with the richest merchandise, are miserable structures, not arched as in Baghdad and the Persian towns, but covered with mats laid on rafters of date trees, which hardly afford protection from the scorching rays of the sun. The streets are irregular, narrow, and unpaved, and the town itself is disgustingly filthy. Of the vast area within the walls, the greater proportion is occupied with gardens and plantations of palm trees, intersected by a number of little canals, cleansed twice daily by the ebb and flow of the tide, which rises here about 9 feet. The largest of these canals, which approaches the old English factory and the palace of the governor, situated about two miles from the river, is continually crowded with small vessels. The town has scarcely any public buildings that deserve notice. It has khans and coffee-houses without number, a wretched hummam (or bath), and upwards of forty mosques, of which one only is worthy of the name; and this, with the palace of the governor, and the old English factory, which are all contiguous to one another, are the only decent buildings in the place. The old English factory, which was established at Bussorah by the East India Company, about the middle of the last century, ceased to exist with the expiration of the trading privileges of the company. The building has now passed into private hands, and the British vice-consul, who protects our trading interests, resides at the modern village of Maghil, which has been built in a healthy position on the right bank of the river a few miles from the Turkish town. The population of Bussorah is a heterogeneous mixture of all the nations in the East, and consists of Turks, Arabs, Indians, Persians, Armenians, Jacobites, and Jews. The Arabs constitute the principal class; and the Turks, though they are masters of the town, are almost the least numerous.

Bussorah is a great emporium of Indian commerce. Six or eight English ships arrive in the course of a year from India; but the chief part of the traffic is carried on in Arabian bottoms; and the merchants of Muscat possess some of the finest vessels that navigate the Indian seas. From various parts of Hindustan Bussorah receives silk, muslin, linen, white and blue cloths for the clothing of the Arabians, gold and silver stuffs, various metals, sandal-wood, and indigo; pearls from Bahrein, and coffee from Mocha; shawls, fruit, and the precious metals from Persia; spices from Java; and European commodities, which are scarce and dear, from different parts. The trade with the interior is conducted by means of caravans to Aleppo and Baghdad, whence the goods are conveyed to Constantinople. The returns are made in Indian goods, bullion, pearls, dates, copper, raw silk, gall-nuts; and the horses, which are very strong and beautiful, are exported in large numbers by the English.

The situation of the town is unhealthy, owing to the inundations of the river, from which noxious exhalations arise; and strangers are commonly attacked by fever after a short residence. The adjoining country is fertile, producing, besides rice, wheat, barley, and dates of different species, a variety of fruits and vegetables, such as apricots, apples, figs, olives, pomegranates, and grapes; and cabbages, broccoli, lettuce, onions, pease, beans, and truffles, in vast quantities. There are whole fields of roses, which the inhabitants cultivate for the purpose of making attar. The liquorice plant also grows amidst the palm groves on the borders of the river.

The city of Bussorah was originally founded by Omar, 636 A.D., on a canal eight miles S.W. from its present site, where the town of Zobeir now stands; and its situation was so favourable for commerce that in a few years it became a large and flourishing city. The canal, however, soon became useless, and the city was abandoned. The present city was conquered by the Turks in 1668, and since that period has been the scene of many revolutions. It was taken in 1777 after a siege of eight months, by the Persians under Sadick Khan. In about a year it fell again into the hands of the Turks, who were again deprived of it by the sheikh of the Montefik Arabs. The town was in the October following recovered by Soliman Pasha, who encountered the sheikh on the banks of the Euphrates, and put him to flight; and it has since remained in the hands of the Turks.

Under the government of the Turks Bussorah has dwindled down to a mere second-rate town, the permanent population at present (1876) being certainly under 10,000. In the river there is perhaps a greater show of activity just now than in past times, as the Turks employ a considerable naval force in the Persian Gulf to support their land operations against the Arabs, and the Bussorah roads form the headquarters of the squadron, while two or three Turkish steamers also ply upon the river, and have their depôts upon its bank. There are two steamers also belonging to the Tigris and Euphrates Navigation Company (besides a war steamer maintained by the British Government in virtue of a special firman), which convey merchandise and passengers between Baghdad and Bussorah; and, lastly, the vessels of the British India Steam Navigation Company visit Bussorah every week from Bombay and Bushire; but as the trade fostered by these means is entirely one of transit, it confers little benefit on the town or its inhabitants. The village of Maghil, however, on the banks of the Euphrates, at the distance of three or four miles from Bussorah, where the wharves and store-house of the European

companies are situated, is becoming a considerable place, and may be expected ultimately to supersede the Turkish town. The terminus of the Constantinople line of telegraph, which furnishes an alternative means of communication between England and India, is at Fáo, near the mouth of the Euphrates, and at the distance of about 60 miles below Bussorah. A good deal of attention has of late years been directed to Bussorah in connection with the proposal for a railway to unite the Mediterranean with the Persian Gulf, either by way of the Tigris or Euphrates valley. In no case, however, would it be desirable to establish the terminus of such a railway at Bussorah, where the climate would prove most destructive to European life. The most eligible site for the terminus would be either at Kowait on the sea-coast, 50 miles south of Bussorah, or at the Persian town of Mohamreh, where the Karún River disembogues into the Euphrates. Quite recently the Turkish Government has decided to dissociate the Bussorah district, with its dependencies, from Baghdad, and to attach it to the newly-created province of Arabia, the headquarters of the pashalic being established at El Hassa; but such an arrangement is not likely to be permanent. (H. C. R.)

BUSTARD (corrupted from the Latin *Avis tarda*, though the application of the epithet[1] is not easily understood), the largest British land-fowl, and the *Otis tarda* of Linnæus, which formerly frequented the champaign parts of Great Britain from East Lothian to Dorsetshire, but of which the native race is now extirpated. Its existence in the northern locality just named rests upon Sibbald's authority (*circa* 1684), and though Hector Boethius (1526) unmistakably described it as an inhabitant of the Merse, no later writer than the former has adduced any evidence in favour of its Scottish domicile. The last examples of the native race were probably two killed in 1838 near Swaffham, in Norfolk, a district in which for some years previously a few hen-birds of the species, the remnant of a plentiful stock, had maintained their existence, though no cock-bird had latterly been known to bear them company. In Suffolk, where the neighbourhood of Icklingham formed its chief haunt, an end came to the race in 1832; on the wolds of Yorkshire about 1826, or perhaps a little later; and on those of Lincolnshire about the same time. Of Wiltshire, Montagu, writing in 1813, says that none had been seen in their favourite haunts on Salisbury Plain for the last two or three years. In Dorsetshire there is no evidence of an indigenous example having occurred since that date, nor in Hampshire nor Sussex within the present century. From other English counties, as Cambridgeshire, Hertfordshire, and Berkshire, it disappeared without note being taken of the event, and the direct cause or causes of its extermination can only be inferred from what, on testimony cited by Mr Stevenson (*Birds of Norfolk*, ii. pp. 1–42), is known to have led to the same result in Norfolk and Suffolk. In the latter the extension of plantations rendered the country unfitted for a bird whose shy nature could not brook the growth of covert that might shelter a foe, and in the former the introduction of improved agricultural implements, notably the corn-drill and the horse-hoe, led to the discovery and generally the destruction of every nest, for the bird's chosen breeding-place was in wide fields—"brecks," as they are locally called,—of winter-corn. Since the extirpation of the native race the Bustard is known to Great Britain only by occasional wanderers, straying most likely from the open country of Champagne or Saxony, and occurring in one part or another of the United Kingdom some two or three times every three or four years, and chiefly in midwinter.

An adult male will measure nearly four feet from the tip of the bill to the end of the tail; and its wings have an expanse of eight feet or more,—its weight varying (possibly through age) from 22 to 32 pounds. This last was that of one which occurred to the younger Naumann, the best biographer of the bird (*Vögel Deutschlands*, vii. p. 12), who, however, stated in 1834 that he was assured of the former existence of examples which had attained the mass of 35 or 38 pounds. The female is considerably smaller. Compared with most other birds frequenting open places the Bustard has disproportionately short legs, yet the bulk of its body renders it a conspicuous and stately object, and when on the wing, to which it readily takes, its flight is not inferior in majesty to that of an Eagle. The bill is of moderate length, but, owing to the exceedingly flat head of the bird, appears longer than it really is. The neck, especially of the male in the breeding-season, is thick, and the tail, in the same sex at that time of year, is generally carried in an upright position, being, however, in the paroxysms of courtship turned forwards, while the head and neck are simultaneously reverted along the back, the wings are lowered, and their shorter feathers erected. In this posture, which has been admirably portrayed by Mr Wolf (*Zool. Sketches*, pl. 45), the bird presents a very strange appearance; for the tail, head, and neck are almost buried amid the upstanding feathers before named, and the breasts are protruded to a remarkable extent. The Bustard is of a pale grey on the neck and white beneath, but the back is beautifully barred with russet and black, while in the male a band of deep tawny-brown—in some examples approaching a claret-colour—descends from either shoulder and forms a broad gorget on the breast. The secondaries and greater wing-coverts are white, contrasting vividly, as the bird flies, with the black primaries. Both sexes have the ear-coverts somewhat elongated—whence doubtless is derived the name *Otis* (Gr. ὠτίς)—and the male is adorned with a tuft of long, white, bristly plumes, springing from each side of the base of the mandible. The food of the Bustard consists of almost any of the plants natural to the open country it loves, but in winter it will readily forage on those which are grown by man, and especially coleseed and similar green crops. To this vegetable diet much animal matter is added when occasion offers, and from an earth-worm to a field-mouse little that lives and moves seems to come amiss to its appetite.

Though not many birds have had more written about them than the Bustard, much remains to be determined with regard to its economy. A moot point, which will most likely always remain undecided, is whether the British race was migratory or not, though that such is the habit of the species in most parts of the European continent is beyond dispute. Equally uncertain as yet is the question whether it is polygamous or not—the evidence being perhaps in favour of its having that nature. But one of the most singular properties of the bird is the presence in some of the fully-grown males of a pouch or gular sack, opening under the tongue. This extraordinary feature, first discovered by James Douglas, a Scotch physician, and made known by Albin in 1740, though its existence was hinted by Sir Thomas Browne sixty years before, if not by the Emperor Frederick II., has been found wanting in examples that, from the exhibition of all the outward marks of virility, were believed to be thoroughly mature; and as to its function and mode of development judgment had best be suspended, with the understanding that the old supposition of its serving as a receptacle whence the bird might supply itself or its companions with water in dry places must be deemed to be wholly untenable. The structure of this pouch—the existence of which in some examples has been well established,—is, however, variable;

[1] It may be open to doubt whether *tarda* is here an adjective. Several of the mediæval naturalists used it as a substantive.

and though there is reason to believe that in one form or another it is more or less common to several exotic species of the family *Otididæ*, it would seem to be as inconstant in its occurrence as in its capacity. As might be expected, this remarkable feature has attracted a good deal of attention (*Journ. für Ornith.* 1861, p. 153; *Ibis*, 1862, p. 107; 1865, p. 143; *Proc. Zool. Soc.* 1865, p. 747; 1868, p. 741; 1869, p. 140; 1874, p. 471), and the researches of Professor Garrod, the latest investigator of the matter, shew that in an example of the Australian Bustard (*Otis australis*) examined by him there was, instead of a pouch or sack, simply a highly dilated œsophagus—the distention of which, at the bird's will, produced much the same appearance and effect as that of the undoubted sack found at times in the *O. tarda*.

The distribution of the Bustards is confined to the Old World—the bird so called in the Fur-Countries of North America, and thus giving its name to a lake, river, and cape, being the Canada Goose (*Bernicla canadensis*). In the Palæarctic Region we have the *O. tarda* already mentioned, extending from Spain to Mesopotamia at least, and from Scania to Morocco, as well as a smaller species, *O. tetrax*, which often occurs as a straggler in, but was never an inhabitant of, the British Islands. Two species, known indifferently by the name of Houbara (derived from the Arabic), frequent the more southern portions of the Region, and one of them, *O. macqueeni*, though having the more eastern range and reaching India, has several times occurred in North-western Europe, and once even in England. In the east of Siberia the place of *O. tarda* is taken by the nearly-allied, but apparently distinct, *O. dybowskii*, which would seem to occur also in Northern China. Africa is the chief stronghold of the family, nearly a score of well-marked species being peculiar to that continent, all of which have been by later systematists separated from the genus *Otis*. India, too, has three peculiar species, the smaller of which are there known as Floricans, and, like some of their African and one of their European cousins, are remarkable for the ornamental plumage they assume at the breeding-season. Neither in Madagascar nor in the Malay Archipelago is there any form of this family, but Australia possesses one large species already named. From Xenophon's days (*Anab.* i. 5) to our own, the flesh of Bustards has been esteemed as of the highest flavour. The Bustard has long been protected by the game-laws in Great Britain, but, as will have been seen, to little purpose. A few attempts have been made to reinstate it as a denizen of this country, but none on any scale that would ensure success. Many of the older authors considered the Bustards allied to the Ostrich, a most mistaken view, their affinity pointing apparently towards the Cranes in one direction and the Plovers in another. (A. N.)

BUSTO ARSIZIO, a town of Italy, in the province of Milan and district of Gallarate, about 19 miles N.W. of the city of Milan by rail. Its church of Santa Maria was planned by Bramante, and contains frescoes by Gaudenzio Ferrari; and St John's is also a noble building. Cotton is manufactured in the town, and the vine is cultivated in the neighbourhood. Population in 1870, 12,909.

BUTADES, wrongly called DIBUTADES, a Greek modeller in clay, whom fable describes as the first who modelled the human face in that material. The story is that his daughter, smitten with love for a youth at Corinth where they lived, drew upon the wall the outline of his shadow; and that upon this outline her father modelled a face of the youth in clay, and baked the model along with the clay tiles which it was his trade to make. This model was preserved in Corinth till Mummius sacked that town. This incident led Butades to ornament the ends of roof-tiles with human faces, a practice which is attested by numerous existing examples. He was a native of Sicyon, and probably lived about 600 B.C., at which date Corinth seems to have been a flourishing centre of working in clay.

BUTCHER-BIRD, a name frequently given to the Shrike family of Birds (*Laniadæ*), and particularly to the Great Grey Shrike (*Lanius excubitor*). See SHRIKE.

BUTE, COUNTY OF, is composed of three groups of islands which lie in the Firth of Clyde, betwixt the coasts of Ayrshire on the east, and Argyllshire on the north and west, viz., Bute, from which the county takes its name, with Inchmarnoch, a mile to westward; the two Cumbraes, less than a mile apart; and Arran, with the Holy Isle and Pladda islet, separated from each other by about a mile; the groups themselves being divided by channels from five to eight or ten miles in width. The area of the county is about 225 square miles. Before the application of steam to navigation and the introduction of the railway system, the voyage from Glasgow to Bute, Cumbrae, or Arran was always tedious and disagreeable, and sometimes fraught with peril, being performed in small and generally open sail-boats, often occupying days, and occasionally even weeks; now, by rail and steamer, the several islands can be reached in an hour and a half or two hours from Glasgow. In consequence of those facilities, and their acknowledged salubrity of climate, beauty and sublimity of scenery, and scientific and historic interest, the chief islands of Buteshire have for years attracted increasing numbers of tourists, artists, and men of science from all parts of the world. Buteshire, with the exception of some half-dozen small estates, is in the hands of four great proprietors. Arran, Holy Isle, and Pladda belong to the duke of Hamilton, and Bute and Inchmarnoch to the noble marquis who derives his title from the former. The Larger Cumbrae is the property of the earl of Glasgow and Lord Bute; and the Lesser Cumbrae, with its single farm, belongs to the earl of Eglinton. The proprietors of Bute and the Larger Cumbrae,—whose residences are respectively Mount Stuart, a few miles from Rothesay, and the Garrison, a handsome marine villa in the heart of Millport,—have given every encouragement to feuing and to all public improvements; consequently the beautiful watering-places in their vicinity have grown rapidly in population and importance. The census of 1871 gives the resident population of Buteshire at 16,977, 7623 males and 9354 females. Of these 10,094 were in Bute, 5259 in Arran, and 1624 in the Cumbraes. Since then the numbers are known to have largely increased, and in summer the population must be vastly greater. The electoral roll, which grows of course with the growth of the better class of feuars and householders, numbers at present 1150 voters. Prior to 1832 Buteshire, alternately with Caithness-shire, sent a member to Parliament,—Rothesay enjoying at the same time the privilege of sharing a representative with Ayr, Campbelton, Inveraray, and Irvine. On the passing of the Reform Bill of 1832, Rothesay was merged in the county, which since then has had a member to itself. Buteshire and Renfrewshire form one sheriffdom, with a sheriff-substitute resident in Rothesay, where are also situated the county buildings, including the court-house, prison, and public offices. The circuit courts are held at Inveraray.

BUTE, the most important of the several islands in the Firth of Clyde which constitute the county of the same name, is situated about 18 miles west of Greenock, and 40 by water from Glasgow. It is about 15 miles in length, extending from the picturesque "Kyles"—the narrow winding strait which separates the island on the north from the district of Cowal—to the Sound of Bute, about 8 miles in width, which separates it on the south from Arran. In breadth the island is unequal, from the deep indentations,

on both sides, of its numerous bays, but it averages from 3 to 5 miles, having on the east the Cumbraes 5 miles and the Ayrshire coast 8 miles off, and on the west Inchmarnoch (with an area of 675 acres) close at hand, and Ardrishaig, the highway to the Hebrides, within little more than two hours' sail of Rothesay.

The island has an area of 31,161 acres, two-thirds of which are arable, the remainder consisting of hill-pasture, plantings, moors, and sheets of water. Of the latter there are six. The largest, Loch Fad, 3 miles from Rothesay, is nearly 3 miles in length and about ¼ mile in breadth. From this copious source the Rothesay cotton-spinning mill, the first establishment of the sort erected in Scotland, derived by gravitation its propelling power. The mill continued in active operation, giving employment to some hundreds of people, until a few years ago, when, from the machinery having become antiquated and other causes, it ceased to be remunerative, and was closed. There are still two factories in the neighbourhood, with more modern machinery, for the weaving of cloth, but they are driven by steam-power. Loch Fad has a peculiar interest attaching to it, from having, on its western bank, the cottage built in 1827 by Edmund Kean, the great tragedian, who there found it "glorious through the loopholes of retreat to peep on such a world." The cottage, after Kean's death, fell into the hands of Mr J. B. Neilson, the ingenious inventor of "the hot-blast," and is now the property of Lord Bute. Notwithstanding the change of hands, the drawing-room is still retained precisely as Kean left it. Loch Ascog, within two miles of Rothesay, is less than Loch Fad, but quite as useful. It covers an area of 72 acres, and supplies the inhabitants of Rothesay with excellent water for domestic purposes. Quien Loch covers 54 acres, Greenan Loch 12, Loch Dhu 9, and Lochantarb 5 acres. The climate of Bute is mild, genial, and healthful, and is likened, not unfrequently, to that of Devonshire or of Montpellier. The mountains of Argyll and the peaks of Arran breaking the clouds as they pass from the Western Ocean, less rain falls on Bute than on any other part of the west coast; and the sea-breeze, generally blowing from the west and south, keeps the air cool in summer, and prevents snow from remaining or frost from continuing long in winter. The soil of Bute, for the most part light and gravelly, produces, under skilful treatment, excellent crops, particularly of potatoes, which, being readily disposed of by the acre while growing, are conveyed in barrels day by day to the Glasgow market. The farmers are a respectable class of men, intelligent, able-bodied, and long-lived. Coal has been found in the island, but of inferior quality and doubtful quantity. Supplies of this indispensable mineral are therefore brought from the fields of Ayrshire and Lanarkshire. Native limestone has been burned and used, but of late years it has given way almost entirely to Irish lime, which is extensively imported for building and manuring purposes. Of soft red sandstone, slate, and whinstone there is no lack, but they are chiefly used in the building of dykes and the gables and back walls of tenements, white sandstone and slates being largely imported for the front elevations and roofing of the better class of houses, which are now rapidly increasing in number. At Kilchattan there is an abundance of superior clay, and a thriving brick and tile work. Granite of a grey complexion, susceptible of a high polish, is also found at Kilchattan.

The islands of Bute and Inchmarnoch, excepting the small estates of Ascog and Ardbeg, the burgh lands, and one or two trifling holdings adjoining the town, belong to the marquis of Bute, whose favourite seat, Mount Stuart, is four miles from Rothesay on the eastern shore. The house, for which a much better site, commanding a view all round the island, might have been found, was begun in 1719 by the second earl, and finished after his death, in 1723, by Lady Bute, a daughter of the first duke of Argyll. It is a plain unpretentious mansion of moderate dimensions, recently much improved internally by the present marquis.

To the geologist, Bute offers little attraction as compared with Arran; yet the masses of conglomerate on the beach and forming the bold cliffs at Craigmore; the dykes of trap which crop up strikingly through the red sandstone and conglomerate at Ascog, and which may be traced shoreward towards Bogany Point and across the island to Ettrick Bay; and the vitrified forts at Dunnagoil (Garrochhead) and Island-bui (Kyles),—whether the result of volcanic action or only of beacon fires is doubtful,—will not be found unworthy of his notice. To the antiquary and the student of mediæval history Bute offers ample scope. The Druidical monuments, and the barrows, cairns, and cists are numerous throughout the island, as are also the remains of ancient chapels. For an account of Rothesay Castle and its deeply interesting historical associations, see ROTHESAY. Another object of interest is St Blane's chapel, picturesquely situated in a sheltered nook in the parish of Kingarth. It is believed to have been founded in the reign of Malcolm Canmore, towards the close of the 11th century, on the site of a much older edifice. This seems not improbable, as St Blane, who is said to have been a nephew of St Cattan, lived in the latter half of the 6th century. At all events, the names of both saints have been perpetuated in connection with the chapel and the neighbouring bay of Kilchattan. In the year 1204, Walter, Steward of Scotland, anxious "for the souls of kings David and Malcolm, and the souls of his own father and mother," as well as for "the salvation of himself and heirs," granted a charter conveying St Blane's, with all its valuable belongings in Bute, "to the monastery at Paisley, and the monks serving God therein." Time out of mind the chapel has been a ruin, surrounded by numerous graves of the forgotten dead; and having passed long ago from the custody of the church, it again belongs, with the lands attached to it, to a Stuart, Lord Bute.

There are still extant and habitable several old mansions in Bute, one or two of which may be pointed out. The most considerable is Kames Castle, three miles north-west of Rothesay. It stands in an extensive well-wooded park opposite the fine bay of the same name. It was long the residence of the Bannatyne family, a member of which, Lord Bannatyne, a judge of the Court of Session, projected the Highland Society in 1784, and founded the village of Port-Bannatyne, an abode of hardy fishermen, and now also a flourishing watering-place. Kames estate and castle are now the property of Lord Bute. Ascog House, about three miles from Rothesay in the opposite direction coastwise, is another old mansion in the Scottish baronial style. Standing on a richly-wooded height, it commands extensive views of the firth, and whether regarded from the road or the water contributes largely to enhance the beauty of perhaps the finest landscape in the island. The estate of Ascog belonged at one time to a branch of the Bute family. In 1815 it was purchased by the late Mr Robert Thom, C.E., of the Rothesay spinning-mill, who acquired celebrity by successfully engineering the introduction of water to the town of Greenock.

The island is divided into four parishes,—Rothesay, New Rothesay, Kingarth, and North Bute.

Rothesay, with its population of 7760 souls, has two Established churches, with a Gaelic chapel, two Free churches, with a Gaelic chapel, one United Presbyterian church, and three chapels—Episcopalian, Baptist, and Roman Catholic; while at Kingarth there are two

churches, Established and Free; at Ascog one, a Free church; and in North Bute an Established and a Free church. The school accommodation is likewise ample, both in town and country.

Touching the origin of the name of Bute, there is considerable doubt. It has been written Both, Bote, Boot, and Botis, and may thus be derived from "Both," which is the Irish for "a cell," St Brendan, an Irish abbot, having, it is said, caused a cell to be erected in the island in the 6th century; or it may have been derived from the old British words "Ey Budh," or the Gaelic words "Ey Bhiod," signifying the "island of corn," or "island of food," from its fertility as compared with the neighbouring islands and Highland districts. Although now all but obsolete, Gaelic was formerly the current language spoken. The Butemen in fighting times were called Brandanes, a distinction which they prized; and the numerous small landed proprietors, in virtue of a charter granted them in 1506 by James IV., took the title of baron, which became hereditary in their families. The title is now all but extinct, the lands which conferred it having passed by purchase from time to time, with one or two trifling exceptions, into possession of the Bute family. The descendants of the Brandanes were among the earliest to take part in the volunteer movement, by furnishing a couple of batteries to Lord Lorne's battalion of Argyll and Bute Artillery Volunteers, as well as a company to the Renfrewshire Rifles.

Great improvements have been recently made and are now (1876) in progress in Bute. The renovation, all but completed, of the grand old castle, and the formation of the esplanades of Rothesay,—together with the erection of an aquarium, and of an iron pier, where the accommodation was wanted, at the entrance to the bay, will tend, with other appreciated advantages, to give the island and shores of Bute a higher place than ever among the attractions of the Clyde. (R. H.)

BUTE, JOHN STUART, THIRD EARL OF (1713–1792), for a brief time prime minister of England, was born in 1713, and was educated at Eton. Horace Walpole, who was one of his contemporaries there, tells us that Bute "studied simples in the hedges about Twickenham." For many years he resided in the remote island of Bute, where he appears to have diligently studied mathematics, mechanics, and natural science. He married the daughter of Mr and the celebrated Lady Mary Wortley Montagu, an alliance which subsequently brought the large Wortley estates into his family. A mere accident introduced him at court; a shower of rain interrupted a cricket match at Cliefden, and led to his services being required by the Prince of Wales. He received a bedchamber appointment in the household of the prince. Prince Frederick died, however, next year, and Lord Bute lived in retirement. On the formation of a separate household for the princess and the young princes, he received the appointment of groom of the stole, somewhat to the dissatisfaction of the old king, George II., who gave him the gold key of office in an ungracious way. In the household of the Prince of Wales Lord Bute acquired great influence over the mind of the youthful heir of the throne and his mother. The scandal of the last century associated his name most intimately with that of the princess, but for this cruel and persistent rumour there appears to be no foundation either in contemporary literature or in the large inedited Bute MSS.

Lord Bute does not appear to have had much to do with the education of the future king and his brothers, which was chiefly left in episcopal hands. He took, however, some part in the direction of his studies, and is known to have read Blackstone's *Commentaries*, when still in MS., with him. He seems also to have inculcated him with the writings of Bolingbroke, whose theory was that a king should not only reign but govern, and who had sketched out the ideal of a patriot king. The constant language of the Princess Dowager, re-echoed by the groom of the stole, was "George, be king!" In 1760 George II. died, and the young king proceeded to put in practice the teachings he had received. This marked an important era in constitutional history. Then began the era of the "king's friends;" the royal will was to be supreme; the ministers were simply to act ministerially, giving expression to and carrying out the sovereign's pleasure. It is manifest that this doctrine weakened the responsibility of ministers and the authority of parliament, and invited dangers in the direction both of absolutism and of anarchy. Bute, however, was prepared to carry out a scheme very like Strafford's "Thorough" with zeal and energy. The day after the accession Bute was made a privy councillor. A little later he was made secretary of state. Afterwards he was made Knight of the Garter. The king told the ministers, "Lord Bute is my very good friend;" and the royal will was expressed through him. The extraordinary spectacle was witnessed, on the meeting of parliament, of a man with no political connection, who had never been in the cabinet, and who had never served in any ministerial office, being practically prime minister. What he was in reality he soon became in name. In the *Shelburne Correspondence* we find him asserting that there was nothing which he could not do. The ministers at the time of the accession, who both in the Eastern and the Western World were maintaining the war with France with the greatest glory and success, were William Pitt, the duke of Newcastle, and Mr Legge. The last, Mr Legge, was ignominiously dismissed. Pitt could not carry the support of the cabinet in his proposal to declare war against Spain, and therefore resigned, —a resignation which probably prevented a dismissal. Such insults were heaped upon the duke of Newcastle that, although he long clung to office, he was at last compelled to resign.

As premier, Bute showed considerable ability. Lord Mansfield said he never knew any man come to business so late who did it so well, and he proved an extremely good speaker. He also gave considerable patronage to literature and art. He had several distinct points of policy. He wished to close the era of war and make peace with France. He wished to sever the political connection between England and Hanover. He wished to humble the dominant Whig families, and to make the king supreme. In all these objects he was to a considerable extent successful. The popular feeling against the peace was intense. Still the minister had secured a large majority in the House of Commons; but although he had spoken much of purity of election, it is not to be denied that there had been extensive bribery in the elections. Confident of the royal support and a parliamentary majority, he seemed secure of a long lease of power.

After being premier for eleven months, to the astonishment of all, he suddenly resigned. He was unable to face the black tide of personal unpopularity which set in so heavily against him. Wilkes's publication of the *North Briton* had both expressed and intensified his unpopularity. He was in danger of being impeached; he was in danger of being torn in pieces by the mob. He went about disguised. He attempted to conciliate popularity by recalling Pitt to office; but Pitt would only return with his Whig friends, to which the king would not consent. Then Lord Bute's courage gave way. His own explanation was, "The ground I stand upon is so hollow that I am afraid, not only of falling myself, but of involving my royal master in my own ruin." But although he resigned office, his influence with the king was hardly impaired. It was the king's custom, at least for some time, to write a minute daily journal of

events and transmit it to Lord Bute. Both Grenville who succeeded him, and Rockingham, who succeeded Grenville, regarded him with the utmost jealousy. Grenville made it an absolute condition that Bute should retire from the presence and counsels of the young king. He retired to Luton; he afterwards travelled on the Continent under the name of Sir John Stuart He complained bitterly that he was not allowed "to enjoy that peace, that liberty, which is the birthright of the meanest Briton, but which has been long denied me."

The influence of Lord Bute over the king was great for a time, but it has been much exaggerated. After a few years it seems to have declined altogether. Both the king and Lord Bute soon disclaimed its existence, and there is no lack of corroboratory evidence But it was impossible to eradicate the notion that there was a back-stairs influence personified in Lord Bute. He was denounced in popular addresses before the king himself as a betrayer of the constitution, and mobs regularly broke his windows. Wilkes reviled him; Junius thundered against him. Lord Chatham declaimed against him as one behind the throne greater than the throne itself. For twenty years he was regarded with invincible hostility and suspicion, yet we find him complaining that he had not the influence of an alderman in obtaining a position for his son. Horace Walpole gives a curious account of an offer being made to Chatham shortly before his death of making him premier with a dukedom, he himself being a secretary of state. The facts are not well ascertained, but Lord Mountstuart, afterwards first marquis of Bute, wrote to assert upon his honour that his father, Lord Bute, assured him that he had not thought of coming into place again.

Lord Bute had purchased an estate at Luton in Bedfordshire, where Adams, the Scottish architect, had built him a magnificent residence. Here he formed an immense library, a superb collection of astronomical and philosophical instruments, and an admirable gallery of pictures, which are preserved in a large house appropriated to them in Warwick Square, London. On the summit of a plain Tuscan pillar in the grounds is an inscription in honour of his great friend and benefactress the Princess Dowager. He took great delight in architecture, and among other edifices built himself a marine villa on the edge of the cliff, in Hampshire, overlooking the Needles and the Isle of Wight. He is said to have been an admirable tutor and father to his children, and to have taken a greater pleasure in simple, natural delights than he could have found in courts. His death was occasioned through that intense love of natural science which had followed him through life. Seeing a new plant on the cliff he climbed towards it, and received a severe fall, which brought on an illness of which he died.

The eleven months' premiership, during which he was mayor of the palace, was a singular episode in his prolonged life,—a remarkable and unconstitutional experiment in politics which has never been repeated. Lord Bute possessed great virtues, great energy and ability, and was as able a premier as Newcastle, Grenville, or Rockingham. But the royal favouritism on which he relied proved the greatest bar to his political success, and has left a slur, exaggerated, but not altogether ill-deserved, on his memory. (F. A.)

BUTLER, ALBAN (1710–1773), a hagiologist, was born in Northampton in 1710. After completing his education at the Roman Catholic college at Douay, he was appointed professor of philosophy, and afterwards professor of divinity. In 1745 he travelled through France and Italy in company with the earl of Shrewsbury and some other gentlemen. On his return he was sent as member of a mission to Staffordshire, but was soon afterwards appointed chaplain to the duke of Norfolk, whose nephew he educated and accompanied on a Continental tour. After returning to England he was made president of the English college at St Omer's, where he remained till his death in 1773. His great work, the *Lives of the Saints*, was first published in 5 vols. 4to, 1745, and has passed through many editions. It exhibits great industry and research, with considerable power of expression, and is in all respects the best work of its kind in English literature.

BUTLER, CHARLES (1750–1832), nephew of the preceding, a miscellaneous writer, was born at London in 1750. He was educated at Douay, and in 1775 entered at Lincoln's Inn. He had considerable practice as a conveyancer, and after the passing of the Act Geo. III. c. 32 was called to the bar in 1791. In 1832 he received the silk gown, and was made a bencher of Lincoln's Inn. He died on the 2d June in the same year. His literary activity was enormous, and the number of his published works is very great. The most important of them are the *Reminiscences*, 1821–1827; *Horæ Biblicæ*, 1797, which has passed through several editions; *Horæ Juridicæ Subsecivæ*, 1804; *Book of the Roman Catholic Church*, which was directed against Southey and excited some controversy; lives of Erasmus, Grotius, and some others. He also edited his uncle's *Lives of the Saints* and Fearne's *Essay on Contingent Remainders*, and completed Hargrave's edition of *Coke upon Littleton*.

BUTLER, JAMES, DUKE OF ORMOND. See ORMOND.

BUTLER, JOSEPH, Bishop of Durham, one of the most distinguished writers on theology and ethics, and perhaps the man of greatest intellectual power in the English church during the 18th century, was born at Wantage, in Berkshire, on the 18th May 1692. His father was a respectable linen-draper of that town, who had retired from business some time before the birth of Joseph, his youngest son. The family belonged to the Presbyterian community, and it was their wish that young Butler should be educated for the ministry in that church. The boy was placed under the care of the Rev. Philip Barton, master of the grammar school at Wantage, and remained there for some years. He was then sent to a dissenting academy at Gloucester, which was afterward removed to Tewkesbury. The head-master was Mr Samuel Jones, a man of considerable abilities, several of whose pupils afterwards attained to eminence in the church. Butler's fellow-student and most intimate friend was Secker, who afterwards became archbishop of Canterbury.

While at this academy two important events occurred in Butler's life. He gradually became dissatisfied with the principles of Presbyterianism, and after much deliberation resolved to join the Church of England. In this resolution his father reluctantly acquiesced. About the same time he began to study with care Clarke's celebrated *Demonstration of the Being and Attributes of God*, which had been published a few years previously. With great modesty and secrecy Butler, who was then in his twenty-second year, wrote to the author propounding certain difficulties with regard to the proofs of the unity and omnipresence of the Divine Being. Clarke answered his unknown opponent with a gravity and care that showed his high opinion of the metaphysical acuteness displayed in the objections, and published the correspondence in later editions of the *Demonstration*. Butler acknowledged that Clarke's reply satisfied him on one of the points, and he subsequently gave his adhesion to the other.

In March 1714 he was entered at Oriel College, Oxford. Little is known of his life at the university; his most attached friend was Edward Talbot, son of Dr William Talbot, afterwards Bishop of Durham. In 1718, on the recommendation of Talbot and Clarke, he was nominated preacher at the Chapel of the Rolls, and continued there till 1726. In 1721 he had been appointed by Bishop

Talbot to the living of Houghton, and in 1725 his kind patron presented him to the wealthy rectory of Stanhope. In the following year he resigned his preachership at the Rolls, and published the first edition of the *Sermons*.

For nearly eight years he remained in perfect seclusion at Stanhope, and our information as to his general mode of life is exceedingly scanty. He was only remembered in the neighbourhood as a man much loved and respected, who used to ride a black pony very fast, and whose known benevolence was much practised upon by beggars. In 1733 he was made chaplain to Lord Chancellor Talbot, and in 1736 prebendary of Rochester. In the same year he was appointed clerk of the closet to Queen Caroline, and began to take part in the brilliant metaphysical society which she loved to gather round her. He met Berkeley frequently, but in his writings does not refer to him.

In 1736 appeared the *Analogy*, which at once took its place as the completest answer to the general deistical reasoners of the times, and as the best defence of revealed religion.

In 1736 Queen Caroline died; on her deathbed she recommended Butler to the favour of her husband. George, however, had not his consort's partiality for metaphysics, and seemed to think his obligation sufficiently discharged by appointing Butler in 1738 to the bishopric of Bristol, the poorest see in the kingdom. The severe but dignified letter in which Butler signified his acceptance of the preferment, must have shown him that the slight was felt and resented. Two years later the bishop was presented to the rich deanery of St Paul's, and in 1746 was made clerk of the closet to the king. In 1747 it is said the primacy was offered to Butler, who declined to accept it, saying that "it was too late for him to try to support a falling church." The story has not the best authority, and though the desponding tone of some of Butler's writings may give it colour, it is not in harmony with the rest of his life; for in 1750 he accepted the see of Durham, vacant by the death of Dr Edward Chandler. His charge to the clergy of the diocese, the only charge of his known to us, is a weighty and valuable address on the importance of external forms in religion. It gave rise to a most absurd rumour that the bishop had too great a leaning towards Romanism.

Of his life at Durham few incidents are known. He was very charitable, and expended large sums in building and decorating his church and residence. His private expenses were exceedingly small. He did not long survive his promotion. Shortly after the change to Durham his constitution began to break up, and he died on the 16th June 1752, at Bath, whither he had removed for his health. He was buried in the cathedral of Bristol, and over his grave a monument was erected in 1834, with an epitaph by Southey. According to his express orders, all his MSS. were burned after his death.

Butler was never married. His personal appearance has been sketched in a few lines by Hutchinson:—"He was of a most reverend aspect; his face thin and pale; but there was a divine placidness which inspired veneration, and expressed the most benevolent mind. His white hair hung gracefully on his shoulders, and his whole figure was patriarchal."

Underneath the meagre facts of his life, eked out by the few letters left by him or anecdotes told about him, there can be traced the outlines of a great but somewhat severe spirit. He was an earnest and deep-thinking Christian, melancholy by temperament, and grieved by what seemed to him the hopelessly irreligious condition of his age. His intellect was profound and comprehensive, thoroughly qualified to grapple with the deepest problems of metaphysics, but by natural preference occupying itself mainly with the practical and moral. Man's conduct in life, not his theory of the universe, was what interested him. His style has frequently been blamed for its obscurity and difficulty. These qualities, however, belong not so much to the form as to the matter of his works. The arguments are invariably compressed, and can never be taken individually. All are parts of one organic whole. Constant attention is thus required in order to grasp the relations of each isolated piece of reasoning. Above all, however, the special obscurity of the *Analogy* results from the difficulty of keeping constantly in mind the exact issue involved. Butler himself resolutely restricts his argument within the narrow limits prescribed for it, but it is difficult for any ordinary reader to keep this constantly in mind.

His great work, *The Analogy of Religion, Natural and Revealed, to the Course and Constitution of Nature*, cannot be adequately appreciated unless taken in connection with the circumstances of the period at which it appeared. It was intended as a defence against the great tide of deistical speculation, which in the apprehension of good men seemed likely to sweep away the restraints of religion, and make way for a general reign of licence. Deism, as a fact in English thought, takes its rise mainly from Locke, though traces of it are not wanting in Herbert of Cherbury. Whether or not the *Essay on the Human Understanding* should be held responsible for its results is a disputed question; but there can be no doubt that from the positions there laid down the general principles of the deists were drawn. Knowledge, in the strict sense of the word, had been restricted by Locke to the perception of the relations among ideas; reason was defined as the faculty which compared and compounded such ideas; and though with regard to God, faith was still admitted, the only part of the divine nature withdrawn from the province of knowledge was the inscrutable essence, which was equally unknown in the case of all real beings. The whole course of nature, including man's moral powers, was therefore subjected to reason; life must be regulated by reason. If, therefore, religion were to enter as a factor into the conduct of man, it must exhibit to reason the title deeds of its existence; Christianity must be reasonable. But with such a view of knowledge it was easy for the deists to make a successful attack upon at least one portion of the Christian scheme. A mystery by its very definition involved elements not capable of being represented in clear ideas; it was therefore unreasonable, and must be absolutely rejected. *Christianity not Mysterious* is the title of Toland's most famous work.

The course of their argument soon carried the deists farther. They were willing to grant the fact of God's existence; it was a dictate of reason. But they were not prepared to go beyond that, and the necessary deductions from it. The truths of natural religion thus took the form of inferences drawn from certain premises; they were displayed in a coherent, perfectly rational system. Revealed religion, on the other hand, was confessedly imperfect, contained things not in accordance with natural reason, inculcated duties on grounds of mere authority, was not universally and completely known, and must therefore be rejected. As Tindal puts it, "No religion can come from a Being of infinite wisdom and perfection but what is absolutely perfect. A religion absolutely perfect can admit of no alteration, and can be capable of no addition or diminution. If God has given mankind such a law, he must likewise have given them sufficient means of knowing it; he would otherwise have defeated his own intent in giving it, since a law, so far as it is unintelligible, ceases to be a law." It was against this whole tendency of thought that Butler directed his *Analogy*. The method and course of his argument will appear more plainly when it has been considered what were the premises on which he proceeded, and what the object he had in view.

Butler is a typical instance of the English philosophical mind. He will admit no speculative theory of things. To him the universe is no realization of intelligence, which is to be deciphered by human thought; it is a constitution or system, made up of individual facts, through which we thread our way slowly and inductively. Complete knowledge is impossible; nay, what we call knowledge of any part of the system is inherently imperfect. "We cannot have a thorough knowledge of any part without knowing the whole." So far as experience goes, "to us probability is the very guide of life." Reason is certainly to be accepted; it is our natural light, and the only faculty whereby we can judge of things. But it gives no completed system of knowledge, and in matters of fact affords only probable conclusions. In this emphatic declaration, that knowledge of the course of nature is merely probable, Butler is at one with Hume, and some of his expressions are exactly paralleled in the writings of the great sceptic, who was a most diligent student of the bishop's works. What can come nearer Hume's celebrated maxim,—"Anything may be the cause of anything else," than Butler's conclusion, "so that any one thing whatever may, for aught we know to the contrary, be a necessary condition to any other?"

It is this strong grasp of the imperfect character of our knowledge of nature and of the grounds for its limitation that makes Butler so formidable an opponent to his deistical contemporaries. He will permit no anticipations of nature, no *a priori* construction of experience. "The constitution of nature is as it is," and no system of abstract principles can be allowed to take its place. He is willing with Hume to take the course of experience as the basis of his reasoning, seeing that it is common ground for himself and his antagonists. In one essential respect, however, he goes beyond Hume. The course of nature is for him an unmeaning expression, unless it be referred to some author; and he therefore makes extensive use of the teleological method. This position is assumed throughout the treatise, and as against the deists with justice, for their whole argument rested upon the presupposition of the existence of God, the perfect Ruler of the world.

The premises, then, with which Butler starts are the existence of God, the known course of nature, and the necessary limitation of our knowledge. What does he wish to prove? It is not his intention *to prove God's perfect moral government over the world or the truth of religion.* His work is in no sense a philosophy of religion. His purpose is entirely defensive; he wishes to answer objections that have been brought against religion, and to examine certain difficulties that have been alleged as insuperable. And this is to be effected in the first place by showing that from the obscurities and inexplicabilities we meet with in nature we may reasonably expect to find similar difficulties in the scheme of religion. If difficulties be found in the course and constitution of nature, whose author is admitted to be God, surely the existence of similar difficulties in the plan of religion can be no valid objection against its truth and divine origin. That this is at least in great part Butler's object is plain from the slightest inspection of his work. It has seemed to many to be an unsatisfactory mode of arguing and but a poor defence of religion; and so much the author is willing to allow. But in the general course of his argument a somewhat wider issue appears. He seeks to show not only that the difficulties in the systems of natural and revealed religion have counterparts in nature, but also that the facts of nature, far from being adverse to the principles of religion, are a distinct ground for inferring their probable truth. He endeavours to show that the balance of probability is entirely in favour of the scheme of religion, that this probability is the natural conclusion from an inspection of nature, and that, as religion is a matter of practice, we are bound to adopt the course of action which is even probably the right one. If, we may imagine him saying, the precepts of religion are entirely analogous in their partial obscurity and apparent difficulty to the ordinary course of nature disclosed to us by experience, then it is credible that these precepts are true; not only can no objections be drawn against them from experience, but the balance of probability is in their favour. This mode of reasoning from what is known of nature to the probable truth of what is contained in religion is the celebrated method of analogy.

Although Butler's work is peculiarly one of those which ought not to be exhibited in outline, for its strength lies in the organic completeness with which the details are wrought into the whole argument, yet a summary of his results will throw more light on the method than any description can.

Keeping clearly in view his premises—the existence of God and the limited nature of knowledge,—Butler begins by inquiring into the fundamental prerequisite of all natural religion—the immortality of the soul. Evidently the stress of the whole question is here. Were man not immortal, religion would be of little value. Now, Butler does not attempt to prove the truth of the doctrine; that proof comes from another quarter. The only questions he asks are—Does experience forbid us to admit immortality as a possibility? Does experience furnish any probable reason for inferring that immortality is a fact? To the first of these a negative, to the second an affirmative answer is returned. All the analogies of our life here lead us to conclude that we shall continue to live after death; and neither from experience nor from the reason of the thing can any argument against the possibility of this be drawn. Immortality, then, is not unreasonable; it is probable. If, he continues, we are to live after death, it is of importance for us to consider on what our future state may depend; for we may be either happy or miserable. Now, whatever speculation may say as to God's purpose being necessarily universal benevolence, experience plainly shows us that our present happiness and misery depend upon our conduct, and are not distributed indiscriminately. Therefore no argument can be brought from experience against the possibility of our future happiness and misery likewise depending upon conduct. The whole analogy of nature is in favour of such a dispensation; it is therefore reasonable or probable. Further, we are not only under a government in which actions considered simply as such are rewarded and punished, but it is known from experience that virtue and vice are followed by their natural consequents—happiness and misery. And though the distribution of these rewards is not perfect, all hindrances are plainly temporary or accidental. It may therefore be concluded that the balance of probability is in favour of God's government in general being a moral scheme, where virtue and vice are respectively rewarded and punished. It need not be objected to the justice of this arrangement that men are sorely tempted, and may very easily be brought to neglect that on which their future welfare depends, for the very same holds good in nature. Experience shows man to be in a state of trial so far as regards the present; it cannot, therefore, be unreasonable to suppose that we are in a similar state as regards the future. Finally, it can surely never be advanced as an argument against the truth of religion that there are many things in it which we do not comprehend, when experience exhibits to us such a copious stock of incomprehensibilities in the ordinary course and constitution of nature.

It cannot have escaped observation, that in the foregoing course of argument the conclusion is invariably from experience of the present order of things to the reasonableness or probability of some other system—of a future state. The inference in all cases passes beyond the field of

experience; that it does so may be and has been advanced as a conclusive objection against it. The following sentences, from one of Hume's *Essays*, set forth this argument in a clear and forcible manner:—"What must a philosopher think of those vain reasoners who, instead of regarding the present scene as the sole object of their contemplation, so far reverse the whole course of nature, as to render this life merely a passage to something further? . . . . Whence, do you think, can such philosophers derive their idea of the gods? From their own conceit and imagination surely. For if they derive it from the present phenomena, it would never point to anything further, but must be exactly adjusted to them. That the divinity may possibly be endowed with attributes which we have never seen exerted, may be governed by principles of action which we cannot discover to be satisfied,—all this will freely be allowed. But still this is mere *possibility* and hypothesis. We never can have reason to infer any attributes or any principles of action in him, but so far as we know them to have been exerted and satisfied. . . . *Are there any marks of distributive justice in the world?* If you answer in the affirmative, I conclude that since justice here exerts itself, it is satisfied. If you reply in the negative, I conclude that you have then no reason to ascribe justice in our sense of it to the gods. If you hold a medium between affirmation and negation, by saying that the justice of the gods at present exerts itself in part, but not in its full extent, I answer, that you have no reason to give it any particular extent, but only so far as you see it *at present* exert itself." (*Works*, ed. 1854, iv. 161–2, *cf.* p. 160.) In short no argument from experience can ever carry us beyond experience itself. However well grounded this reasoning may be, it altogether misses the point at which Butler aimed, and is indeed a misconception of the nature of analogical argument. Butler never attempts to *prove* that a future life regulated according to the requirements of ethical law is a reality; he only desires to show that the conception of such a life is not irreconcilable with what we know of the course of nature, and that consequently it is *not unreasonable* to suppose that there is such a life. Hume, it will be observed, readily grants as much, though he hints at a formidable difficulty which the plan of the *Analogy* prevented Butler from facing, the proof of the existence of God. Butler seems willing to rest satisfied with his opponents' admission that the being of God is proved by reason, but it would be hard to discover how, upon his own conception of the nature and limits of reason, such a proof could ever be given. It has been said that it is no flaw in Butler's argument that he has left atheism as a possible mode of viewing the universe, because his work was not directed against the atheists. It is, however, in some degree a defect; for his defence of religion against the deists rests on a view of reason which would for ever preclude a demonstrative proof of God's existence.

If, however, his premises be granted, and the narrow issue kept in view, the argument may be admitted as perfectly satisfactory. From what we know of the present order of things, it is not unreasonable to suppose that there will be a future state of rewards and punishments, distributed according to ethical law. When the argument from analogy seems to go beyond this, a peculiar difficulty starts up. Let it be granted that our happiness and misery in this life depend upon our conduct,—are, in fact, the rewards and punishments attached by God to certain modes of action, the natural conclusion from analogy would seem to be that our future happiness or the reverse will probably depend upon our actions in the future state. Butler, on the other hand, seeks to show that analogy leads us to believe that our future state will depend upon our present conduct. His argument, that the punishment of an imprudent act often follows after a long interval may be admitted, but does not advance a single step towards the conclusion that imprudent acts will be punished hereafter. So, too, with the attempt to show that from the analogy of the present life we may not unreasonably infer that virtue and vice will receive their respective rewards and punishments hereafter; it may be admitted that virtuous and vicious acts are naturally looked upon as objects of reward or punishment, and treated accordingly, but we may refuse to allow the argument to go further, and to infer a perfect distribution of justice dependent upon our conduct here. Butler could strengthen his argument only by bringing forward prominently the absolute requirements of the ethical consciousness, in which case he would have approximated to Kant's position with regard to this very problem. That he did not do so is, perhaps, due to his strong desire to use only such premises as his adversaries the deists were willing to allow.

As against the deists, however, he may be allowed to have made out his point, that the substantial doctrines of natural religion are not opposed to reason and experience, and may be looked upon as credible. The positive proof of them is to be found in revealed religion, which has disclosed to us not only these truths, but also a further scheme not discoverable by the natural light. Here, again, Butler joins issue with his opponents. Revealed religion had been declared to be nothing but a republication of the truths of natural religion (Tindal, *Christianity as Old as the Creation*), and all revelation had been objected to as impossible. To show that such objections are invalid, and that a revelation is at least not impossible, Butler makes use mainly of his doctrine of human ignorance. Revelation had been rejected because it lay altogether beyond the sphere of reason and could not therefore be grasped by human intelligence. But the same is true of nature; there are in the ordinary course of things inexplicabilities; indeed we may be said with truth to know nothing, for there is no medium between perfect and completed comprehension of the whole system of things, which we manifestly have not, and mere faith grounded on probability. Is it unreasonable to suppose that in a revealed system there should be the same superiority to our intelligence? If we cannot explain or foretell by reason what the exact course of events in nature will be, is it to be expected that we can do so with regard to the wider scheme of God's revealed providence? Is it not probable that there will be many things not explicable by us? From our experience of the course of nature it would appear that no argument can be brought against the possibility of a revelation. Further, though it is the province of reason to test this revealed system, and though it be granted that, should it contain anything immoral, it must be rejected, yet a careful examination of the particulars will show that there is no incomprehensibility or difficulty in them which has not a counterpart in nature. The whole scheme of revealed principles is, therefore, not unreasonable, and the analogy of nature and natural religion would lead us to infer its truth. If, finally, it be asked, how a system professing to be revealed can substantiate its claim, the answer is, by means of the historical evidences, such as miracles and fulfilment of prophecy.

It would be unfair to Butler's argument to demand from it answers to problems which had not in his time arisen, and to which, even if they had then existed, the plan of his work would not have extended. Yet it is at least important to ask how far, and in what sense, the *Analogy* can be regarded as a positive and valuable contribution to theology. What that work has done is to prove to the consistent deist that no objections can be drawn from reason or experience against natural or revealed religion, and, consequently, that the things objected to are not incredible

and may be proved by external evidence. But the deism of the 17th century is a phase of thought that has no living reality now, and the whole aspect of the religious problem has been completely changed. To a generation that has been moulded by the philosophy of Kant and Hegel, and by the historical criticism of Strauss and the later German theology, the argument of the *Analogy* cannot but appear to lie quite outside the field of controversy. To Butler the Christian religion, and by that he meant the orthodox Church of England system, was a moral scheme revealed by a special act of the divine providence, the truth of which was to be judged by the ordinary canons of evidence. The whole stood or fell on historical grounds. A speculative construction of religion was a thing abhorrent to him, a thing of which he seems to have thought the human mind naturally incapable. The religious consciousness does not receive from him the slightest consideration, whereas it is with its nature and functions that the scientific theology of the present time is almost entirely occupied. The *Analogy*, it would appear, has and can have but little influence on the present state of theology; it was not a book for all time, but was limited to the controversies and questions of the period at which it appeared.

Throughout the whole of the *Analogy*, it is manifest that the interest which lay closest to Butler's heart was the ethical. His whole cast of thinking was practical. The moral nature of man, his conduct in life, is that on account of which alone an inquiry into religion is of importance. The systematic account of this moral nature is to be found in the famous *Sermons preached at the Chapel of the Rolls*, especially in the first three. In these sermons Butler has made substantial contributions to ethical science, and it may be said with confidence, that in their own department nothing superior in value appeared during the long interval between Aristotle and Kant. To both of these great thinkers he has certain analogies. He resembles the first in his method of investigating the end which human nature is intended to realize; he reminds of the other by the consistency with which he upholds the absolute supremacy of moral law.

In his ethics, as in his theology, Butler had constantly in view a certain class of adversaries, consisting partly of the philosophic few, partly of the fashionably-educated many, who all participated in one common mode of thinking. The key-note of this tendency had been struck by Hobbes, in whose philosophy man was regarded as a mere sensitive machine, moved solely by pleasures and pains. Human nature had come to be looked upon as essentially selfish; disinterested actions were sneered at as impossibilities by the many, and were explained away into modifications of selfishness by the scientific moralists. Cudworth and Clarke, it is true, had tried to place ethics on a nobler footing, but their speculations had been of the abstract kind, which was always distasteful to Butler. They were not practical enough, were not sufficiently "applicable to the several particular relations and circumstances of life." He desired to base ethical law not on abstract theory, but on the actual facts of human nature.

The fundamental view of things from which he starts in his inquiry may be called the teleological. "Every work, both of nature and art, is a system; and as every particular thing both natural and artificial is for some use or purpose out of or beyond itself, one may add to what has been already brought into the idea of a system its conduciveness to this one or more ends." Ultimately this view of nature, as the sphere of the realization of final causes, rests on a theological basis; but Butler does not introduce prominently into his ethics the specifically theological groundwork, and may be thought willing to ground his principle on experience. The ethical question then is, as with Aristotle, what is the τέλος of man? He is placed in the world with many courses of action open to him. What is that line of activity which is correspondent to, or is the realization of, his true nature? The answer to this question is to be obtained by an analysis of the facts of human nature, whence, Butler thinks, "it will as fully appear that this our nature, *i.e.*, constitution, is adapted to virtue, as from the idea of a watch it appears that its nature, *i.e.*, constitution or system, is adapted to measure time." Such analysis had been already attempted by Hobbes, and the result he came to was that man naturally is adapted only for a life of selfishness,—his end is the procuring of pleasure and the avoidance of pain. A closer examination, however, shows that this at least is false. The truth of the counter propositions, that man is φύσει πολιτικός, naturally social, and that the full development of his being is impossible apart from society, becomes manifest on the slightest examination of the facts. For while self-love plays a most important part in the human economy, there is no less evidently a natural principle of benevolence, prompting actions which have for their end the good of others. Moreover, among the particular passions, appetites, and desires there are some whose tendency is as clearly towards the general good as that of others is towards our own satisfaction. Finally, that principle in man which reflects upon actions and the springs of actions, which approves some and disapproves others, unmistakably sets the stamp of its approbation upon conduct that tends towards the general good. It is clear, therefore, that we were made for society; man is ζῶον πολιτικόν, and from this point of view the sum of practical morals might be given in Butler's own words,—"that mankind is a community, that we all stand in a relation to each other, that there is a public end and interest of society, which each particular is obliged to promote." But deeper questions remain.

The threefold division into passions and affections, self-love and benevolence, and conscience, is Butler's celebrated analysis of human nature. In the handling of the several parts he shows remarkable psychological power, and succeeds in obviating many of the difficulties drawn from the principles of the selfish theory of ethics. He is especially concerned to show that self-love and benevolence are in no sense opposed to one another. This he does by examining the function of self-love and the relation it bears to the passions. The special desires or affections are the expressions of wants in our nature which are to be satisfied by the possession of definite things. The objects of the desires are therefore the things naturally adapted to satisfy them, and not the pleasure which is the accompaniment of satisfaction. The passions tend towards their objects as ultimate ends, and are consequently unselfish or disinterested. On the other hand, self-love aims at procuring happiness for the individual; and happiness means the general satisfaction of desires. Self-love is therefore distinct from the particular desires, but is completely dependent on them. Its end is the attainment of pleasure, and it desires external things only as means towards this. In itself it has no actual content; it only directs the particular passions towards their ends, and frequently, by fixing its attention too much upon its own goal, personal happiness, is in danger of defeating its own endeavours. Self-love is therefore distinct from and in no way opposed to the particular affections which are themselves disinterested. Just as little opposition is there between self-love and disinterested benevolence. An affection which finds its gratification in some external object and rests in it as a final end, is in no sense opposed to self-love. This is one of the most important parts of Butler's ethical psychology.

Up to this point he has merely analyzed the various parts of human nature, and has pointed out the course of action corresponding to each. But in a system or organism the parts do not exist for themselves but for the whole. The idea of human nature is not completely expressed by saying that it consists of reason and the several passions. "Whoever thinks it worth while to consider this matter thoroughly should begin by stating to himself exactly the idea of a system, economy, or constitution of any particular nature; and he will, I suppose, find that it is one or a whole, made up of several parts, but yet that the several parts, even considered as a whole, do not complete the idea, unless in the notion of a whole you include the relations and respects which these parts have to each other." This fruitful conception of man's ethical nature as an organic unity Butler owes directly to Shaftesbury and indirectly to Aristotle; it is the strength and clearness with which he has grasped it that gives peculiar value to his system.

The special relation among the parts of our nature to which Butler alludes is the subordination of the particular passions to the universal principle of reflection or conscience. This relation is the peculiarity, the *cross*, of man; and when it is said that virtue consists in following nature, we mean that it consists in pursuing the course of conduct dictated by this superior faculty. Man's function is not fulfilled by obeying the passions, or even cool self-love, but by obeying conscience. That conscience has a natural supremacy, that it is superior in kind, is evident from the part it plays in the moral constitution. We judge a man to have acted wrongly, *i.e.*, unnaturally, when he allows the gratification of a passion to injure his happiness, *i.e.*, when he acts in accordance with passion and against self-love. It would be impossible to pass this judgment if self-love were not regarded as superior in kind to the passions, and this superiority results from the fact that it is the peculiar province of self-love to take a view of the several passions and decide as to their relative importance. But there is in man a faculty which takes into consideration all the springs of action, including self-love, and passes judgment upon them, approving some and condemning others. From its very nature this faculty is supreme in authority, if not in power; it reflects upon all the other active powers, and pronounces absolutely upon their moral quality. Superintendency and authority are constituent parts of its very idea. We are under obligation to obey the law revealed in the judgments of this faculty, for it is the law of our nature. And to this a religious sanction may be added, for "consciousness of a rule or guide of action, in creatures capable of considering it as given them by their Maker, not only raises immediately a sense of duty, but also a sense of security in following it, and a sense of danger in deviating from it." Virtue then consists in following the true law of our nature, that is, conscience. Butler, however, is by no means very explicit in his analysis of the functions to be ascribed to conscience. He calls it the Principle of Reflexion, the Reflex Principle of Approbation, and assigns to it as its province the motives or propensions to action. It takes a view of these, approves or disapproves, impels to or restrains from action. But at times he uses language that almost compels one to attribute to him the popular view of conscience as passing its judgments with unerring certainty on individual acts. Indeed his theory is weakest exactly at the point where the real difficulty begins. We get from him no satisfactory answer to the inquiry, What course of action is approved by conscience? Everyone, he seems to think, knows what virtue is, and a philosophy of ethics is complete if it can be shown that such a course of action harmonizes with human nature. When pressed still further, he points to justice, veracity, and the common good as comprehensive ethical ends. His whole view of the moral government led him to look upon human nature and virtue as connected by a sort of pre-established harmony. His ethical principle has in it no possibility of development into a system of actual duties; it has no content. Even on the formal side it is a little difficult to see what part conscience plays. It seems merely to set the stamp of its approbation on certain courses of action to which we are led by the various passions and affections; it has in itself no originating power. How or why it approves of some and not of others is left unexplained. Butler's moral theory, like those of his English contemporaries and successors, is defective from not perceiving that the notion of duty can only have real significance when connected with the will or practical reason, and that only in reason which wills itself have we a principle capable of development into an ethical system.

It has frequently been made the ground of objection to Butler's philosophy of man's moral nature that he did not carry his analysis far enough, and that he accepted as ultimate facts what are really compounded of simpler elements. His distinction between self-love and the passions has in particular been rejected on the plea that the end of appetite or desire is not the object suited to satisfy it, but pleasure, or at least the removal of uneasiness. This last, however, is fairly included under Butler's expression, "gratification of the passions." The removal of uneasiness no doubt results in pleasure, but it is not the pleasure that removes the uneasiness. What is really sought is the object that will satisfy us, that will fill up the want in our existence, and with which we, so to speak, identify ourselves. With regard to the general objection, even were it granted that self-love and benevolence are developments from the passions, the relations between them would none the less hold good. Self-love is not superior to the passions, because it has been originally created their superior, but because under the sphere of its inspection and decision the particular desires are included; it stands above them because they form the objects upon which it works. Further, growth or development, deeply considered, does not invalidate authority or superiority in kind. The ethical consciousness, like all other parts of our nature, grows; it is only by degrees and slowly that man comes to the full recognition of the reason that lies in him and forms his true personality. He is moral at first only δύναμει, and the varying conditions of experience are requisite in order to afford the means of development from this mere potentiality. The customary observances and legal precepts, in which the common ethical consciousness of humanity has given expression to itself, are being continually tested by comparison with the formal requirements of the inner law of duty, and change gradually as they are found at various epochs to be imperfect realizations of reason. The ultimate goal of all such progress is that state of ethical observance in which rights and duties come to be recognized as the outcome of human personality, and the realization of true freedom.

Bartlett, *Memoirs of Butler*, 1839. The best edition of Butler's works is that in 2 vols., Oxford. Editions of the *Analogy* are very numerous; that by Fitzgerald, 1849, contains a valuable Life and Notes. Whewell has published an edition of the *Three Sermons*, with Introduction. The analyses of the *Analogy* by Duke (1847) and Wilkinson (1847), Chalmers's *Prelections* (posthumous works, ix.), Napier's *Lectures*, (1864), and Swainson's *Handbook* may be consulted with advantage. For the history of the religious works contemporary with the *Analogy*, see Lechler, *Ges. d. Engl. Deismus;* Pattison, in *Essays and Reviews;* Hunt's *Religious Thought in England*, vols. ii. and iii.; A. S. Farrar, *Critical History of Free Thought*. For Butler's ethics see Mackintosh, Whewell, and Jouffroy. It is quite surprising that German historians of ethics should ignore Butler. Feuerlein, Fichte, Wuttke, and Trendelenburg totally omit mention of his name; Vorländer, in his *Ges. d. Phil. Moral, Rechts- und Staats-lehre d. Engländer u. Franzosen*, devotes three pages to Butler and fifteen to Bolingbroke. (R. AD.)

BUTLER, SAMUEL (1612–1680), whose name appears to have been spelt Boteler in official documents to the end of his life, was born at Strensham on the Avon in Worcestershire. He was baptized on the 8th of February 1612. His father, who was of the same name and was then churchwarden, is variously represented as a substantial farmer (owning a small freehold, and leasing from Sir William Russel a considerable farm valued at £300 a year), and as "a man of but slender fortune," who was barely able to educate his son at a free school. The author of *Hudibras* was apparently educated at the college (or cathedral) school, Worcester, and the house in which he was born was pulled down (being considered incapable of repair) about 1873. Hardly any other particulars of his youth are recorded, and his later education (if he received any) is equally uncertain. He has been loosely asserted (as is the case with many other distinguished persons of his century) to have studied at both Cambridge and Oxford, but the balance of testimony seems to be against his having belonged to either university. The time between the completion of his education (*circa* 1630) and the Restoration, a period of fully thirty years, appears to have been spent by him in three different households, with Mr Jefferies of Earl's Croome in Worcestershire, with the countess of Kent at Wrest in Bedfordshire, and with Sir Samuel Luke at Woodend or Cople Hoo in the same county. He served Mr Jefferies in the capacity of justice's clerk, and is supposed to have thus laid the foundation of his remarkable knowledge of law and law terms. He also employed himself at Earl's Croome in general study, and particularly in painting, which he is said to have thought of adopting as a profession. It is probable, however, that art has not lost by his change of mind, for, according to one of his editors, in 1774 his pictures "served to stop windows and save the tax; indeed they were not fit for much else." At Wrest, where he is said to have been gentleman to the countess, he pursued his studies in painting, drawing, and music; probably, also, in other directions, for Wrest contained a good library. Here he met and worked for Selden. But his third sojourn, that at Cople Hoo, was not only apparently the longest, but also much the most important in its effects on his career and works.

We are nowhere informed, nor is it at all clear, in what capacity Butler served Sir Samuel Luke, or how one who was not only in temper and sympathies, but also from early associations, a decided royalist, came to reside in the house of a noted Puritan and Parliament man. In the family of this "valiant Mamaluke," who, whether he was or was not the original of *Hudibras*, was certainly a rigid Presbyterian, "a colonel in the army of the Parliament, scoutmaster-general for Bedfordshire and governor of Newport Pagnell," Butler must have had the most abundant opportunities of studying from the life those who were to be the victims of his great future satire. But we know not how long he held his situation (whatever it was) under the knight of Cople, and we hear nothing positive of him till the Restoration, immediately after which he was appointed secretary to Lord Carbery (then President of Wales) and steward of Ludlow Castle. Contradictory documents exist respecting his tenure of the latter office, one speaking of him as "late steward" in January 1662, the other (a protection against arrest) addressed to him as steward in September 1667. About this time he married a Mrs Herbert, according to Aubrey a widow with a good jointure, on whose means he lived comfortably. Aubrey knew him well and could hardly be wrong on such a point, especially as his testimony as to Butler's living in comparative comfort is confirmed by another authority to be afterwards mentioned. It should, however, be observed that other accounts state that Mrs Herbert's fortune was lost through bad securities. Late in 1662 the first part of *Hudibras* was published. On the 26th of December Pepys bought it, and though neither then nor afterwards could he see the wit of it, he repeatedly testifies to its extraordinary popularity. This popularity is most clearly proved by the issue of a pirated edition within a month, and by the appearance of a spurious second part within the year. This latter compliment (which it will be remembered was also paid to Butler's spiritual ancestor Cervantes) determined the poet to bring out the second part, which was licensed on November 7, 1663, and which if possible exceeded the first in popularity. From this time till 1678, the date of the publication of the third part, we hear nothing certain and hardly anything at all of Butler. He appears at some period to have visited France. He is said to have received a gift of £300 from Charles II., and to have been secretary to Buckingham when the latter was Chancellor of the University of Cambridge. Most of his biographers, in their eagerness to prove the ill-treatment which Butler is supposed to have received, disbelieve both these stories, perhaps without sufficient reason. It must be allowed that it is scarcely a valid argument that Butler, if he had been secretary to Buckingham, would not have spoken so severely of that nobleman in his *Characters* (*Remains*, 1759), when it is remembered that he satirized Sir Samuel Luke, to whom he held nearly the same relation, with certainly equal virulence. Two years after the publication of the third part he died (September 25, 1680), and was buried by his friend Mr William Longueville (a bencher of the Middle Temple) in the churchyard of St Paul's, Covent Garden. He was, we are told, "of a leonine-coloured hair, sanguine, choleric, middle-sized, strong." Portraits exist at Oxford and elsewhere which represent him as somewhat hard-featured. Two personal anecdotes, and perhaps two only, are recorded of him. One is the well-known story which tells how Wycherly laboured hard to secure for the neglected poet the patronage of Buckingham, how an interview was at last arranged, from which the duke was, alas! called off by the passage of "a brace of ladies," and how the opportunity was lost. The other bears suspicious marks of having been made up as setting for a witticism of Lord Dorset's. Dorset, it seems, was anxious to know the author of *Hudibras*, and prevailed on a common friend to bring him to a tavern. At the first bottle Butler was quiet and reserved, at the second full of wit and spirits, at the third dull and stupid,—upon which Dorset's comment was that Butler was "like a nine-pin, little at both ends, but great in the middle." Of these stories it may be said, as of most such, that they may be true and cannot be proved to be false.

Of the neglect of Butler by the Court something must be said. It must be remembered that the complaints on the subject supposed to have been uttered by the poet all occur in the spurious posthumous works, that men of letters have been at all times but too prone to complain of lack of patronage (a fact which makes it probable that Dryden, Otway, Oldham, &c., in alluding to Butler, spoke as the proverb of that day went, "one word for him and two for themselves"), that the actual service rendered by Butler was rendered when the day was already won, and that the pathetic stories of the poet starving and dying in want are contradicted by the best authority—Mr C. Longueville (son of the poet's friend)—who asserted that Butler, though often disappointed, was never reduced to anything like want or beggary, and did not die in any person's debt. But the most significant story on the subject is Aubrey's, that "he might have had preferments at first, but would not accept any but very good, and so got none."

Three monuments have been at different times and places erected to the poet's memory,—the first in 1721 by

Alderman-Barber in Westminster Abbey. This was the occasion of some rather misplaced wit from Pope and others. In 1786 a tablet was placed in St Paul's, Covent Garden, by some inhabitants of that parish. This was destroyed in 1845. Some thirty or forty years ago another was set up at Strensham by a Mr Taylor of that place. Perhaps the happiest epitaph on him is one by Dennis, which (borrowing, indeed, its most striking expression from Cowley) sets forth that Butler "was a whole species of poets in one."

Butler's published works during his life consisted of the three parts of *Hudibras* (the second and third were republished together in 1674, with notes by the author); of an *Ode on Duval* (the famous highwayman); and of two pamphlets attributed to Prynne. In 1715 three volumes, entitled *Posthumous Works of Mr S. Butler*, were published with great success. Their contents, however, are all spurious except one or two short pieces. The poet's papers remained in the hands of his friend Mr Longueville, and were not published till 1759, when Mr Thyer, librarian at Manchester, edited two volumes of verse and prose under the title of *Genuine Remains*. The most remarkable of the prose writings are characters of the kind popular in the 17th century, and partaking largely of the faults usual in such pieces. To this some additional fragments were added in 1822; a fragment of a tragedy on Nero is also spoken of. In 1726 Hogarth executed some illustrations to *Hudibras*, which are among his earliest but not, perhaps, happiest productions. In 1744 Dr Zachary Grey published an edition of *Hudibras*, which has been repeatedly reprinted, and has formed (with that of Nash in 1793) the basis of all subsequent editions. It contains an enormous mass of notes, displaying little critical or literary power, but abounding in curious information. A worthy edition is still to seek; but that of the late Mr R. Bell is convenient, and supplies much information, which is generally accurate. Mr Bohn's (of *Hudibras* only) is also useful. Butler's lesser works would of themselves fairly sustain, though perhaps they would hardly create, a great reputation. Abundance of happy thought, of ingenious expression, and of vigorous verse, may be found in the *Miscellaneous Thoughts*, the *Ode on Duval*, and the *Satires* on the Royal Society (*The Elephant in the Moon*) and on *Critics*. But the splendour of *Hudibras* has somewhat paled their fire.

Hudibras itself, though probably quoted as often as ever, has perhaps dropped into the class of books which are more quoted than talked of, and more talked of than read. In reading it, it is of the utmost importance to comprehend clearly and to bear constantly in mind the purpose of the author in composing it. This purpose is evidently not artistic but polemic, to show in the most unmistakable characters the vileness and folly of the anti-royalist party. Anything like a regular plot—the absence of which has often been deplored or excused—would have been for this end not merely a superfluity but a mistake, as likely to divert the attention and perhaps even enlist some sympathy for the heroes. Anything like regular character-drawing would have been equally unnecessary and dangerous—for to represent anything but monsters, some alleviating strokes must have been introduced. The problem, therefore, was to produce characters just sufficiently unlike lay-figures to excite and maintain a moderate interest, and to set them in motion by dint of a few incidents not absolutely unconnected,—meanwhile to subject the principles and manners of which these characters were the incarnation to ceaseless satire and raillery. The triumphant solution of the problem is undeniable, when it has once been enunciated and understood. Upon a canvas thus prepared and outlined, Butler has embroidered a collection of flowers of wit, which only the utmost fertility or imagination could devise, and the utmost patience of industry elaborate. In the union of these two qualities he is certainly without a parallel, and their combination has produced a work which is unique. The poem is of considerable length, extending to more than ten thousand verses, yet Hazlitt hardly exaggerates when he says that "half the lines are got by heart;" indeed a diligent student of later English literature has read great part of *Hudibras* though he may never have opened its pages. The tableaux or situations, though few and simple in construction, are ludicrous enough. The knight and squire setting forth on their journey; the routing of the bear-baiters; the disastrous renewal of the contest; Hudibras and Ralph in the stocks; the lady's release and conditional acceptance of the unlucky knight; the latter's deliberations on the means of eluding his vow; the Skimmington; the visit to Sidrophel, the astrologer; the attempt to cajole the lady, with its woeful consequences; the consultation with the lawyer, and the immortal pair of letters to which this gives rise complete the argument of the whole poem. But the story is as nothing; throughout we have little really kept before us but the sordid vices of the sectaries, their hypocrisy, their churlish ungraciousness, their greed of money and authority, their fast and loose morality, their inordinate pride. The extraordinary felicity of the means taken to place all these things in the most ridiculous light has never been questioned. The doggrel metre, never heavy or coarse, but framed so as to be the very voice of mocking laughter, the astounding similes and disparates, the rhymes which seem to chuckle and to sneer of themselves, the wonderful learning with which the abuse of learning is rebuked, the subtlety with which subtle casuistry is set at nought can never be missed. Keys like those of L'Estrange are therefore of little use. It signifies nothing whether Hudibras was Sir Samuel Luke of Bedfordshire or Sir Henry Rosewell of Devonshire, still less whether Ralph's name in the flesh was Robinson or Pendle, least of all that Orsin was perhaps Mr Gosling, or Trulla possibly Miss Spencer. Butler was probably as little indebted to mere copying for his characters as for his ideas and style. These latter are in the highest degree original. The first notion of the book, and only the first notion, Butler undoubtedly received from *Don Quixote*. His obligations to the *Satyre Ménippée* have been noticed by Voltaire, and though English writers have sometimes ignored or questioned them, are not to be doubted by any student of the two books. The art (perhaps the most terrible of all the weapons of satire) of making characters without any great violation of probability represent themselves in the most atrocious and despicable light was never perhaps possessed in perfection except by Pithou and his colleagues and by Butler Against these great merits some defects must certainly be set. As a whole, the poem is no doubt tedious, if only on account of the very blaze of wit, which at length almost wearies us by its ceaseless demands on our attention. It should, however, be remembered that it was originally issued in parts, and therefore (it may be supposed) intended to be read in parts, for there can be little doubt that the second part was written before the first was published. A more real defect, but one which Butler shares with all his contemporaries from Jonson downwards, is the tendency to delineate humours instead of characters, and to draw from the outside rather than from within. This also may be partially palliated by some remarks made above.

Attempts have been made without much success to trace the manner and versification of *Hudibras*, especially in Cleveland and in the *Musarum Deliciæ* (lately reprinted) of Sir John Mennis (Pepys's Minnes) and Dr Smith. But if it had few ancestors it had an abundant offspring. A

list of seventeen direct imitations of *Hudibras* in the course of a century was given in the *Retrospective Review*, and may be found in Mitford's *Butler*. Portions of it have been at different times translated into Latin with no great success. Complete translations of considerable excellence have been made into French by John Townley (London, 1757, 3 vols.), and into German by D. W. Soltau (Riga, 1787); specimens of both may be found in Bell's edition. Voltaire tried his hand at a compressed version, but not happily. (G. SA.)

BUTLER, WILLIAM ARCHER (1814–1848), a brilliant writer on theology and the history of philosophy, was born at Annerville, near Clonmel, probably in 1814. His father was a Protestant, his mother a Roman Catholic, and he was brought up in the Romish faith. At the age of nine he was sent to Clonmel school, where he distinguished himself not so much by rigid attention to his class work as by general brilliancy and power. Even when a boy he was strongly drawn towards the imaginative and poetical, and some of his early verses show an astonishing precocity. After leaving Clonmel school he entered Trinity College, Dublin. Two years before he had joined the Protestant church. His career at college was remarkably brilliant. The studies to which he specially devoted himself were the literary and metaphysical; and he was particularly noted for the extreme beauty of his style, both in speaking and in written exercises. In 1834 he gained the ethical moderatorship, newly instituted by Provost Lloyd, and continued in residence at college, pursuing his favourite studies. Many papers were about this time contributed by him to the *Dublin University Magazine*; it is to be regretted that these have not been collected. In 1837 he made up his mind to enter the church, and in the same year he was elected to the professorship of moral philosophy, specially founded for him through the exertions of Provost Lloyd. About the same time he was presented to the prebend of Clondehorka, in Donegal, and resided there when not called by his professorial duties to Dublin. In 1842 he was promoted to the rectory of Raymoghy. His lectures and his sermons were equally admired for their strength of thought and richly imaginative style. In 1845 appeared in the *Irish Ecclesiastical Journal* his *Letters on Development*, written under a great press of business, but in every way worthy of the author, and the best reply made to the famous essay of Newman which had called them forth. Butler's life was but short. He caught cold when returning one day from public service; the cold terminated in fever, which proved fatal in a few days. He died on the 5th July 1848. His *Sermons*, published in two vols. by Woodward and Jeremie, have been universally recognized as among the most important recent contributions to theology. They are remarkable not only for rare brilliancy of style, but for subtilty and force of thought. The diction is at times too ornate and rhetorical, but it is not to be forgotten that the sermons were hurriedly written, were never revised, and were all the work of a young man. Their uncommon excellence deepens the regret at the early death of the author. The *Lectures on the History of Ancient Philosophy*, edited in a masterly manner by W. Hepworth Thompson (2 vols. 1856; 2d ed., 1 vol. 1875), have taken their place as the best among the few British works on the history of philosophy. The introductory lectures, and those on the early Greek thinkers, are not of the highest value, and though they evidence wide reading, do not show the complete mastery over the material that is found in Schwegler or Zeller. The lectures on Plato, however, are of great value, and furnish a most admirable and enthusiastically conceived exposition of the Platonic system. Butler was evidently attracted by the lofty spirit of Platonism, and sets forth its main features with the warmest admiration. In details he is not altogether to be trusted, but any defects in his scholarship are amply supplied in the valuable notes of his editor.

See *Memoir of W. A. Butler*, prefixed by Rev. J. Woodward to first series of *Sermons*.

BUTO, an Egyptian goddess, called in the language *Uat* or *Uatiu*, the eponymous goddess of the town Buto in Northern Egypt, supposed to be modern Kum el Aman and Kum el gir, on the western banks of the Damietta branch of the Nile. The goddess herself personified Lower Egypt, and as such wore the *tesĕr* or red crown, whether in her human form, or typified as a vulture, or uræus; in which respect she resembled Nat or Neith. She presided over fire, and resided in it or the solar eye, and was identified with the goddesses Bast and Sexet or Merienptah, of which she may have been another type. Buto was also considered to represent the Greek Latona, and the uræus Mahur, and this again connected her with Lower Egypt or the Delta. She was considered to be the regent and mistress of the lands Pe and Tep, districts of her nome, of the land of *Hanebu* or the Greeks, and of *Tāneter*, the divine land or Arabia, also of *Anhu* the capital of *Xrut*, another of the nomes of Lower Egypt. The ideas of the Greeks that she personified darkness, and that the *mygale* or shrew-mouse was sacred to her, are incorrect; for, as already stated, *Uat* presided over the element of fire, and the shrew-mouse appears from the inscriptions on the base of figures of this little animal to have been dedicated to Horus, like the Apollo Sminthens of the Greeks. The name was also given to the capital of a nome ruled over by the deities Har or Horus and Uat or Buto. The Greeks supposed that Buto was the capital of Chemmites or Phthenotes close to the Boutikè Lake, the present Burullos, near the old Sebennytic branch of the Nile. It contained several temples, and in that of Buto oracles were delivered, and the temple was 10 *orgyiai* or fathoms high. The most remarkable object, however, in it was the monolith shrine 40 cubits or about 60 feet square, with a roof of stone, 4 cubits or about 6 feet thick, and 5000 tons weight. It was brought from Elephantina. It appears from an inscription found at Cairo that, during the Persian occupation of Egypt, Khabash, then the ruler of Egypt, had given the nomos Phthenotes to the state of Buto, but that this arrangement was not recognized by Xerxes. Subsequently the older arrangement was restored by Ptolemy Lagus about 313 B.C.

Herodotus, ii. 155; Reinisch, *Denkmäler in Miramir*, s. 201; Wilkinson, *Mann. and Cust.*, iii. 330, 331, iv. 271–3, v. 40; Brugsch, *Geographie*, i. s. 58; Jablonski, *Panth. Ægypt*, iii. 84–116; *Zeitschrift für ægyptische Sprache*, 1871, p. 1 and *foll.*

BUTRINTO, a fortified town of European Turkey on the coast of Albania, in the sandjak of Delvino, directly opposite the island of Corfu, and situated at the mouth of a stream which connects the Lake of Vatzindro with the bay. It has a small harbour, and is the seat of a Greek bishop. In the neighbourhood are the ruins of the ancient *Buthrotum*, consisting of a Roman wall, about a mile in circumference, and some remains of both later and Hellenic work. Buthrotum was a Roman colony in the time of Strabo, but makes little figure in ancient history. The modern city belonged to the Venetians till 1797, when it was seized by the French, who in 1799 had to yield to the Russians and Turks. Population, 1500.

BUTTER, is the fatty portion of the milk of mammalian animals. The milk of all mammals contains such fatty constituents, and butter from the milk of goats, sheep, and other animals has been and may be used; but that yielded by cow's milk is the most savoury, and it alone really constitutes the butter of commerce. The milk of the various breeds of cattle varies widely in the proportion of fatty matter it contains; its richness in this respect being

greatly influenced by season, nature of food, state of the animals' health, and other considerations. While the proportion of cream to milk in the case of most breeds ranges from one-twentieth to one-tenth; in the case of the celebrated Alderney cattle it amounts to as much as from three to four-tenths. Dr Parkes (*Practical Hygiene*) gives the following as the average composition of unskimmed milk having a sp. gr. of 1·030 :—

Casein	4·0
Fat	3·7
Lactin (Sugar of Milk)	5·0
Salts	0·6
Total Solids	13·3
Water	86·7

On a low average each pint of milk ought to yield a full half-ounce of butter. The fat or butter is disseminated through freshly-drawn milk in minute, clear globules, each of which is enclosed in a thin membranous sac or bag; and being specifically lighter than the mass of the fluid, the globules gradually rise to the surface, bringing mixed with them a proportion of milky matter, and form cream. Usually the cream is skimmed off the surface of the milk for making butter, but by some the churning is performed on the milk itself without waiting for the separation of the cream. The operation of churning causes the rupture of the oil sacs, and by the coalescence of the fat so liberated butter is formed. Details regarding churning and the preparation of butter generally will be found under DAIRY.

Fresh or unsalted butter of good quality should present a rich straw-yellow colour. At ordinary temperatures it has a firm uniform consistency, while it is soft enough to cut and spread easily under the knife without breaking or crumbling. It should possess a faint sweet odour, and a bland, soft, delicate flavour, melting in the mouth without any indication of grittiness. Pure butter is a complex chemical compound, consisting in large part of fats or glycerides of the non-volatile acids, palmitic acid, and butyroleic acid, with occasionally stearic acid. With these there occur small proportions of glycerides of the volatile acids, butyric, capronic, caprylic, and caprinic acid, to which the butter owes its distinguishing flavour and characteristics, as it has the non-volatile acids in common with other fats, though in different proportions. Butter when unadulterated and prepared with ordinary care should contain at least 85 per cent. of pure fat, the remainder consisting of casein, water, and salt. The casein is derived from milk, which is never perfectly washed out, but in butter of good quality this ought not to amount to more than from 3 to 5 per cent. Water may be present to the extent of from 5 to 10 per cent. without the butter being subject to a charge of adulteration; and a small proportion of salt is commonly worked into the butter in its preparation, but in what is sold as fresh or sweet this should only be from ½ to 2 per cent. of the whole weight.

When butter is exposed to the air for some time, especially in warm weather, or in hot, confined situations, it quickly becomes rancid, acquiring thereby a distinct disagreeable odour and a biting taste, owing to the development of a volatile fatty acid under the influence of a species of fermentation, which is doubtless caused by the nitrogenous substance, casein, it contains. The more completely, therefore, all milky and curdy matter is washed out of butter the less will be the tendency to set up and develop fermentation. The preservation or curing of butter depends for its efficacy on the employment of some agency by which fermentative action may be prevented; but there are also several ways by which its development may be retarded and the material kept sweet for a considerable period. Rancidity may be corrected to some extent by melting the affected butter and pouring it into ice-cold water. As a means also of retarding rancidity, butter is in some parts of France and the East melted up and heated till the water it may contain is evaporated, when the casein which rises as a scum to the surface is carefully skimmed off; but butter cannot be so melted without injuriously affecting its delicate flavour. By keeping fresh butter in a very cool place covered with pure water renewed daily, it will remain sweet for a considerable time. A still better method, recommended by M. Payen (*Substances Alimentaires*) is to use water acidulated with either tartaric acid or vinegar. It is also said that sugar in the form of a syrup poured over the butter is an excellent medium for retarding rancid fermentation. Butter, however, which is to be kept for a considerable length of time is "cured," or preserved by incorporating with it some substance or substances which act upon the nitrogenous material it contains, and thus prevent fermentation; and for this purpose common salt is the agent chiefly relied on. The salt used should be pure, dry, and finely powdered. About 5 per cent. of salt is sufficient for the purpose of curing; and when the quantity exceeds 8 per cent. it ought to be regarded as an adulteration. Butter very lightly salted for keeping only a short time is said to be powdered. A mixture much used for curing butter in Continental dairies is thus prepared:—One part each of sugar and nitre are mixed up with two parts of common salt and reduced to a very fine powder. This mixture is thoroughly kneaded into the butter in the proportion of about 1 oz. to every ℔. After standing over for a fortnight butter so prepared will be ready for use and have a soft, agreeable taste, which it will retain a long time. In the preservation of all butter, the exclusion of air, as much as possible, is of the utmost consequence. It is, therefore, packed for sale in oaken kegs or glazed earthenware jars, filled quite full, and covered with a clean linen cloth on which salt is sprinkled. When in use the kegs should also be closely covered over, and the surface of the butter kept under brine.

Butter of good quality is a most digestible form of fat, while its flavour is so delicate and little pronounced that it is always acceptable to the palate. It is used most extensively by all classes, not only in the direct form with bread at nearly every meal, but also as entering very largely into the preparation of pastry, puddings, sauces, fancy cakes, and biscuits. Taking into account the daily consumption of this article, it is evident that the amount used in a year by a population such as that of Great Britain must be very great, an inference borne out by the fact that in 1875 the imports were 1,619,808 cwts., valued at £9,050,025, and, though no means exist of accurately estimating the home produce, it may safely be regarded as equal to the whole imports. The countries whence butter is imported into Great Britain are chiefly Germany, Holland, Denmark, and especially France. A large proportion of the French butter comes from the department of Calvados—Isigny being the centre of the best butter-making district. The value of the total produce of France in 1867 was estimated at 250 millions of francs.

Butter is a substance which affords great scope for adulteration, and its composition makes accurate detection of certain foreign matters a matter of considerable labour and difficulty. Other animal fats, such as lard, beef and mutton dripping, and tallow, with certain vegetable fats, are the chief adulterants. Such adulterations may be suspected by their characteristic smell, and detected by their different melting points, by microscopical examination, and by their ethereal solutions. Messrs Angell and Hehner have proposed a convenient method of estimating the fusing points of fat by placing a given weight of definite size on the fat, and observing the temperature at which it sinks into the substance. They find that the sinking-point for genuine butter

is remarkably constant, and that it is affected in proportion to the amount and sinking point of any adulterant fats used. Their analysis of butter depends upon the much smaller proportion of non-volatile, insoluble fatty acids it contains, as compared with fats used as adulterants.

Under the name of butterine an artificial substitute for butter has been introduced in America, and imported into England from New York. It is the same as the artificial butter or "margarine-mouries," which has been for some years manufactured in Paris according to a method made public by the eminent chemist M. Mège-Mouries. Having surmised that the formation of butter contained in milk was due to the absorption of fat contained in the animal tissues, M. Mouries was led to experiment on the splitting up of animal fat. The process he ultimately adopted consisted in heating finely-minced beef suet with water, carbonate of potash, and fresh sheep's stomachs cut up into small fragments. The mixture he raised to a temperature of 45° C. (113° Fahr.) The influence of the pepsine of the sheep's stomach with the heat separated the fat from the cellular tissue; he removed the fatty matter, and submitted it when cool to powerful hydraulic pressure, separating it into stearin and oleomargarin, which last alone he used for butter-making. Of this fat about the proportions of 10 ℔ with 4 pints of milk and 3 pints of water were placed in a churn, to which a small quantity of arnotto was added for colouring, and the whole churned together. The compound so obtained when well washed was in general appearance, taste, and consistency like ordinary butter, and when well freed from water it was found to keep a longer time. According to French official reports artificial butter goes much further as food than the genuine article, and forms a perfectly wholesome dietetic material. The Parisian *octroi* officials have recognized the efficiency of the substitute by imposing on it the same duties which are chargeable on ordinary butter. The company established for the manufacture in France had in 1874 seven manufactories, in which four hundred men were employed. There can be no doubt that a pure, sweet fat, such as is manufactured by the process of M Mège-Mouries is a safer and more wholesome article than the unsavoury rancid butter which is sold so freely among the poorer classes. See Dairy.

BUTTERFLIES and MOTHS, the common English names applied respectively to the two groups of Insects which together form the order *Lepidoptera* (Gr. λεπίς, a scale, and πτερόν, a wing), an order characterized by the constant presence, in a greater or less degree, of scales on the wings. The two groups may, as a rule, be readily distinguished from each other, although, so far as our present knowledge goes, there is nothing in the structure or habits of either group which divides it entirely from the other. All butterflies are diurnal in their flight, while moths, with many exceptions, are crepuscular or nocturnal.

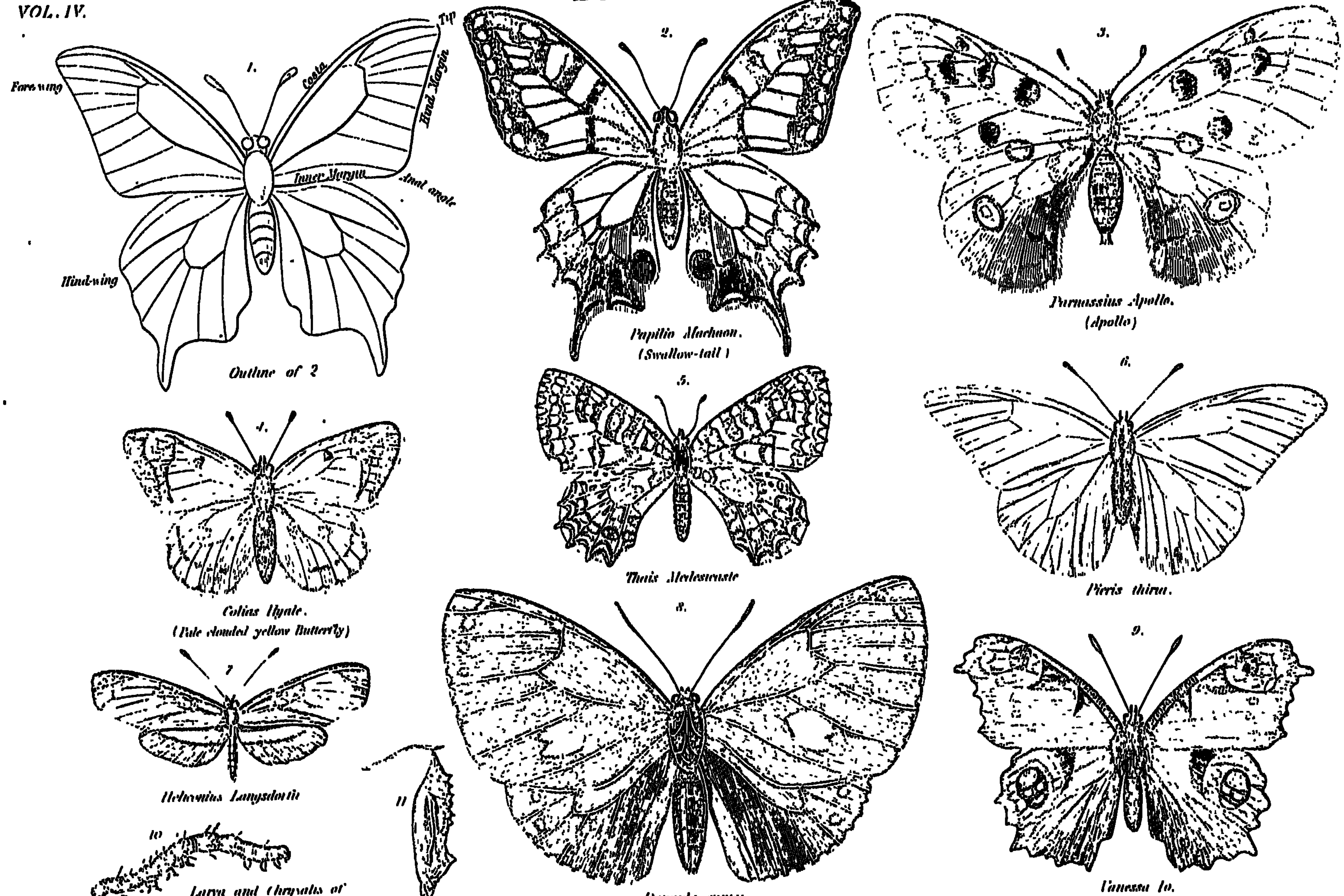
icture. The bodies of butterflies and moths, like those of all other insects, consist of three distinct parts—the head, bearing the organs of sense; the thorax, the organs of locomotion; and the abdomen, the organs of generation.

ad. On the head are placed (1) the antennæ, composed of numerous articulations, and supposed to be organs of hearing. They differ greatly in form among the *Lepidoptera*; those of butterflies, however, agreeing generally in having their ends knobbed or clubbed, hence the term Rhopalocera (ῥόπαλον, a club; κέρας, a horn), often applied to this group. The antennæ of moths assume a great variety of forms—prismatic, serrate, pectinate, moniliform, and filiform,—and are often beautifully feathered, especially in the males, whose antennæ are usually ampler than those of the females; but in no case are they knobbed, as in the great majority of butterflies. Owing to this variety in the form of their antennæ, moths have been termed Heterocera (ἕτερος, various; κέρας, a horn). In butterflies these organs are also straight, and stand out rigidly in front of the head, while in moths they are usually curved and can generally be folded back on the body. (2) The eyes in the *Lepidoptera* consist of two masses of hexagonal facets, placed one on each side of the head, and forming what are known as compound eyes. These contain in some cases no fewer than 16,000 facets each, while in many species a pair of *ocelli*, or simple eyes, are found concealed among the scales and placed between the compound organs. The hairy appearance of the eyes in many of the *Nymphalidæ* is owing to the presence of minute hairs planted at the angles of the numerous facets. Compound eyes are not found among the larvæ of butterflies and moths, but they are in most cases provided with six ocelli on each side of the head. (3) The mouth, the parts of which in insects are considered by comparative anatomists to be typically developed in the masticatory mouth of beetles (*Coleoptera*), assumes in butterflies and moths the suctorial form—the latter being merely a modification of the former; thus the mandibles, labium, and labrum, which are fully developed when the nature of the food renders mastication necessary, are in a rudimentary condition in the *Lepidoptera*, whose chief food is the nectar of flowers, while the maxillæ, on the other hand, are enormously developed; being concave on their inner sides, these by approximating form a tube known as the proboscis or tongue. This when at rest is coiled up into a ball in front of the head, and is partly concealed by the palpi projecting on both sides. In the moths belonging to the family *Bombycidæ*, the organs of the mouth are rudimentary, so that these insects after entering upon the imago state are incapable of feeding.

The thorax bears the organs of locomotion, consisting of three pairs of legs and two pairs of wings. The former are covered with hairs and scales, and terminate in hooks modified to suit the habits of the various species. Butterflies use the legs almost entirely for resting, very rarely for walking, and in some groups, as the *Nymphalidæ*, the front pair is rudimentary. The wings consist of a double layer of colourless membrane traversed by numerous nervures (Plate XXVII. fig. 1), and covered with minute scales implanted in the wing membrane by a short stalk, and placed together like tiles on a roof. The scales vary in form in different species and in different portions of the wings of the same species, while under a high power of the microscope they are seen to be minutely corrugated; and it is to these corrugations acting upon the colourless rays of light, and producing the phenomena of "interference," that many of the loveliest butterflies owe the brilliancy of their wings. The splendour of those organs in the majority of butterflies, and in some moths, is sometimes equally shared by both sexes, but more usually the females are less conspicuously coloured than the males. This difference, amounting often to total dissimilarity, Darwin, in accordance with his descent-theory, attributes in great part to the action of sexual selection. "Several males," he says, "may be seen pursuing the same female." The latter he supposes selects the most gaily-coloured, and thus the plainer-coloured males have been gradually eliminated; but there is no proof whatever that the female shows any such discrimination in selecting a mate, while many known facts seem to point in an opposite direction. Mr A. R. Wallace maintains, on the other hand, that the duller colours of the females have been acquired for protective purposes, the females requiring such protection more than the males owing to their generally slower flight, and to the fact that after impregna-

Thorax. Wings.

BUTTERFLIES



Outline of 2

Papilio Machaon.
(Swallow-tail)

Parnassius Apollo.
(Apollo)

Colias Hyale.
(Pale clouded yellow Butterfly)

Thais Medesicaste

Pieris thiru.

Heliconius Langsdorfii

Danaida cunae

Vanessa Io.
(Peacock)

Larva and Chrysalis of
Vanessa Io
(Peacock)

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tion they take several days to deposit their eggs, during which the life of the male is of no further consequence to the perpetuation of the species. Whatever may be the true interpretation of this phenomenon, it is certain that many butterflies and moths of both sexes are so coloured as to be to a greater or less extent protected thereby. Many moths, which rest by day clinging to the trunks of trees, so exactly resemble in the colour of their upper wings the bark on which they rest as only to be distinguished on close examination; while many small species which habitually rest on leaves are often mistaken for the droppings of birds. The upper surfaces of the wings of butterflies are in almost all cases the more gaily coloured, and when at rest, these are raised perpendicularly over the back, so as only to expose the under surfaces, which are often dull coloured, and in some cases have been shown to be directly imitative of surrounding objects. The best example of this is to be found in the Malayan butterfly, *Kallima paralekta*, and its Indian ally, *Kallima inachis*, both brilliant and conspicuous insects on the wing, but which no sooner alight than they become invisible. The under surfaces of their wings, though varying greatly, yet form in every case a perfect representation of a leaf in some stage or other of decay, the butterfly at the same time disposing of the rest of its body so as to bear out the deception. How this is effected is best told by Mr Wallace, who was the first to observe it, in his valuable work on the Malay Archipelago.

"The habit of the species is always to rest on a twig and among dead or dried leaves, and in this position, with the wings closely pressed together, their outline is exactly that of a moderately sized leaf slightly curved or shrivelled. The tail of the hind wings forms a perfect stalk and touches the stick, while the insect is supported by the middle pair of legs, which are not noticed among the twigs and fibres that surround it. The head and antennæ are drawn back between the wings so as to be quite concealed, and there is a little notch hollowed out at the very base of the wings, which allows the head to be retracted sufficiently."

Moths, when at rest, have the hind wings folded close to the body, while the fore wings cover all, and it is the latter that usually show an assimilation in colour to surrounding nature. Many butterflies and moths, there seems good reason to believe, are coloured in imitation of other and often widely different species possessing some special means of protection, as sting or nauseous juices, the mimetic forms, it is supposed, sharing with their models in immunity from the attacks of insectivorous animals. The phenomena of mimickry were first observed by Bates among the *Heliconidæ*, a family of South American butterflies, remarkable for their great numbers, the gaudiness of their colouring in both sexes and on both surfaces of their wings, and for their comparative slowness of flight. It was found that, owing to the nauseous nature of their juices, those brilliant butterflies were left unmolested by insect-eaters. It was also observed that several species of a genus closely allied to our Cabbage Butterflies, totally different both in the colour and form of the wings from the *Heliconidæ*, so closely resembled particular species of the latter as not to be distinguishable from them on the wing. Exactly similar phenomena have been observed in the tropical regions of Asia and Africa, where the similarly protected *Danaïdæ* and *Acræidæ* find imitators among the otherwise unprotected Papilios and Diademas. There are two families of day-flying moths, *Sesiidæ* and *Ægeriidæ*, with clear transparent wings, the scales being confined mainly to the margins and nervures, which in their wings and in the form and colour of their bodies might be readily mistaken for bees or wasps, a similarity recognized in such specific names as *bombiciformis, apiformis, vespiformis*, &c., applied to different species of these moths. Other species of the same "clear wing" group have opaque wings closely resembling those of certain species of *Coleoptera* found in the same neighbourhood, and these have their wings when at rest closed over their bodies like the elytra of beetles.

Metamorphosis.

Butterflies and moths undergo complete metamorphosis, that is, after emerging from the egg, and before attaining the full development of the imago, they pass through the larva and pupa stages—the latter being one of total inactivity in so far as the outward manifestations of life are concerned. The eggs vary greatly in shape, and are deposited in a great variety of situations—on the under sides of leaves, on the outside of the cocoon, as in the Vapourer Moth (*Orgyia antiqua*), the female of which is wingless, glued together in rings round the smaller branches of fruit trees, as in *Clisiocampa neustria*, or in the interior of hives, the larvæ afterwards feeding on the wax, as in the Honey-comb Moth (*Galleria cerella*). They thus show a remarkable instinct in depositing their eggs in situations where the larvæ may afterwards obtain their appropriate food, although they themselves can have no knowledge of that food.

Caterpillar.

The caterpillar emerges from the egg usually in a week or ten days. Unlike the perfect insect it is provided with a masticatory mouth. It has three pairs of legs on the anterior segments of its body, corresponding to the six legs of the future imago, besides which it is provided with a variable number of conical feet or *prolegs* placed posteriorly, and which are merely processes of the external covering of the caterpillar. Goossens, a Continental naturalist, has recently observed that the number of prolegs in some species differs at different ages, and gives a case in which a caterpillar with originally six prolegs acquired two additional pairs after the third moult. The body cavity is almost entirely occupied with the digestive system, and with that concerned in the production of the silky material used in forming the cocoon. Silk is secreted as a viscous fluid in tubes, which after many convolutions widen into a large reservoir filled with the yellow liquid, narrowing again into a tube extending to the mouth, where it communicates with the outside by means of a conical and jointed papilla known as the *spinneret*. Through this organ the viscous fluid is forced in two exceedingly delicate streams which coalesce, and on exposure to the atmosphere harden into a single continuous thread. The silky material is not completely formed till the caterpillar reaches maturity. Caterpillars are either smooth skinned or more or less covered with hairs; in the former case they are a favourite food of insectivorous animals, while in the latter they are almost universally rejected,—recent investigations on this subject going to prove that the hairs on certain species of caterpillars have a power of stinging, somewhat analogous to that possessed by the hairs on the surface of a nettle.

No sooner does the caterpillar emerge from the egg than it begins to eat voraciously, and in a few days has grown so large that a change of skin becomes necessary. The old skin is cast off, and with it the entire internal lining of the alimentary canal, and in the majority of butterflies and moths five such changes take place before the caterpillar has attained its full growth, while the Tiger Moth (*Arctia caja*) is said to cast its skin at least ten times. Those moultings do not usually affect the appearance of the caterpillar, except in enlarging it; but in the case of *Samia cecropia*, a species of *Bombycidæ*, the larvæ are said to pass from black to various shades of green and azure-blue in the course of their moultings. The larvæ of the family *Psychidæ*—the larger members of which are found in America and Australia—have the curious habit of constructing cases which they carry about with them, and within which they afterwards undergo transformation. Each larva has but a single case, and when this gets too narrow it splits longitudinally and is enlarged by interpos-

ing a new portion between. Moths and butterflies remain in the larval condition for periods varying from three years, as in the Goat Moth (*Cossus ligniperda*), to a few weeks, as in the Cabbage Butterfly (*Pieris brassicæ*), which usually has two broods in the season, while many species whose larvæ leave the egg in autumn, as the Blue Butterfly (*Polyommatus alexis*), remain torpid throughout winter at this stage, and waken up to resume feeding in spring. During this period they increase enormously in weight; thus the larva of the Privet Hawk Moth (*Sphinx ligustri*) which casts its sixth and last skin on the twenty-second day after emerging from the egg, attains its greatest size ten days after, having in the meantime increased to 11,312 times its original weight; while the Goat Moth (*Cossus ligniperda*), which remains in the larval condition for three years, has grown in that period 72,000 times heavier. Having attained its full growth the instincts of the caterpillar undergo a change; it ceases to eat and begins to weave a couch or cocoon by which it is more or less enclosed. It then throws off its skin and appears as a pupa or chrysalis incapable of eating or of locomotion, the only apparent sign of life which it manifests being a convulsive twitching when irritated. Examined more closely, however, life is seen to be exerted in very great intensity in this stage of apparent quiescence. The immense digestive system of the caterpillar dwindles greatly, the rudiments of wings begin to show themselves, forming slight prominences on each side of the chrysalis shell, while the organs of the masticatory mouth are being transformed into those of the suctorial. In assuming the pupa condition caterpillars dispose of themselves in a great variety of ways. Many, like the common Cabbage Butterfly, ascend walls and palings, to which they attach themselves by a silken belt, others, as silkworms, spin around them a solid cocoon of pure silk; while the majority of Sphinx Moths form burrows in the ground, which they line with silk and afterwards varnish to keep out the moisture,—one of these (*Sphinx ligustri*) remaining thus buried from August till June. Those larvæ which feed on the wood of trees, as *Cossus ligniperda*, generally form tough cocoons of chips of wood and of silk within the tunnels which they have bored in the tree, and their pupæ have the power of forcing themselves along those passages till they reach the bark, where they remain until about to emerge from the egg, when they pierce it also. The cocoon of the Puss Moth (*Cerura vinula*), composed of the same materials as in the preceding instance, is usually placed in a crevice of the bark of a tree, where by exposure to the atmosphere it becomes hard as horn, the moth only making its escape after discharging a liquid by which one end of the cocoon is softened. Hairy caterpillars are usually deficient in silk, and in forming their cocoons mix what they have of this with the hairs of their body. A beautiful net-like cocoon is woven by a South American moth belonging to the *Bombycidæ*, which it suspends from the top of an outstanding leaf. "When the caterpillar," says Bates, "begins its work it lets itself down from the tip of the leaf which it has chosen by spinning a thread of silk, the thickness of which slowly increases as it descends. Having given the proper length to the cord (about 6 inches) it proceeds to weave its elegant bag, placing itself in the centre and spinning rings of silk at regular intervals, connecting them at the same time by means of cross threads, so that the whole when finished forms a loose web with quadrangular meshes of nearly equal size throughout." The duration of the pupa stage varies from a few weeks to several months; it varies also in the same species according to the season at which it becomes encased; thus the pupa of *Vanessa urticæ* at the beginning of summer usually develops in fourteen days, and at midsummer in eight or nine days, while if it becomes encased in autumn it remains a pupa during the winter. By applying heat the process can be accelerated, and it can be equally retarded by refrigeration. When mature the pupa case cracks towards the anterior end, and the butterfly or moth crawls forth with wings which, though at first small and crumpled up, in a few hours attain their full size. The male insect goes in search of the female, and when the latter has deposited her eggs the main object in the life of the imago is attained and both sexes die. Among the *Bombycidæ* this occurs in two or three days, owing to the atrophied condition of the organs of the mouth. With butterflies courtship is generally a more prolonged affair, several males pursuing the same female, and breaking each others wings in the conflicts that thus frequently ensue. Butterflies appear in many cases to be gregarious, flying in great flocks. Bates states that at one place in South America he noticed eighty different species flying about in enormous numbers in the sunshine, and these, with few exceptions, were males, the females remaining within the forest shades. Darwin also describes a "butterfly shower," which he observed ten miles off the South American coast, extending as far as the eye could reach; "even by the aid of the telescope," he adds, "it was not possible to see a space free from butterflies. That they are occasionally migratory as well as gregarious is borne out by the observations of Sir J. Emerson Tennent, who witnessed in Ceylon a mighty host of butterflies of a white or pale yellow hue, "apparently miles in breadth and of such prodigious extension as to occupy hours and even days uninterruptedly in their passage."

Imago.

Food.

The food of Lepidopterous insects consists chiefly of the sweet liquids drawn from the nectaries of flowers, which they reach by means of their long proboscis or tongue. Many of the *Sphingidæ* are said to do this without settling on the flowers, and one of these, the Humming Bird Hawk Moth of South America (*Macroglossa titan*), in its mode of flight and of poising itself before a flower while extracting the juice, bears such close resemblance to certain of the smaller humming birds inhabiting the same district, that Bates often shot it for one of the latter, and it was only after considerable experience that he learnt to distinguish the bird from the moth when on the wing. Although their food is thus usually the sweetest liquids drawn from loveliest vessels, still some of the most brilliant species seem to prefer more vulgar fare. Thus the showy Purple Emperor (*Apatura iris*) prefers above all things to suck the juices of putrid animal substances, and the surest way to secure specimens of this butterfly is by setting such baits near its haunts. Mr Wallace states that in Malacca he caught a large and brilliant butterfly which had settled on the dung of some carnivorous animal, where he had also observed it on the previous day, and he adds that it is a habit of many of the finest butterflies to suck up the liquid from muddy spots on the roadside.

Distribution.

Butterflies and moths are widely distributed all over the globe, occurring, however, in greatest variety and abundance in tropical lands. They are found as far north as Spitzbergen, on the Alps to a height of 9000 feet, and to double that height on the Andes. In Britain there are only 66, and in the whole of Europe 390 species of butterflies; while within one hour's walk of Pará in Brazil, Bates found no fewer than 700 species. There are 1910 species of British moths, the majority of which are nocturnal and crepuscular; while in tropical America day-flying moths seem to be most common, and may be seen in company with the sunshine-seeking butterflies. This paucity of nocturnal moths has been attributed to the great number of night-flying or crepuscular insectivorous bats and birds which haunt those regions. Many species both of moths and of butterflies have a very wide distribution; the Painted Lady (*Vanessa*

cardui), a common British species, being found in every quarter of the globe; and our finest butterfly, the Swallow Tail (*Papilio machaon*), occurring throughout Europe, Asia as far as the Himalayas, and South Africa. Other species are extremely local, as the Scotch Argus (*Lycæna artaxerxes*), confined to a few Scottish hillsides. Keferstein estimates the total number of *Lepidoptera* at 66,000 species—6000 butterflies and 60,000 moths. That such estimates, however, are not to be relied on is sufficiently proved by the fact that Bates gives the number of species as above 200,000. The geographical distribution of certain groups of *Lepidoptera* has been well wrought out by Mr Wallace and other naturalists who have studied them in their native homes; but the division of this great order into geographical zones has still to be satisfactorily accomplished. Koch has recently proposed to place them in five such groups—(1) the European or Western fauna, including Northern Asia, the North of Africa (a region exceedingly poor in *Lepidoptera*, owing probably to the want of great forests, and to the marshy nature of vast tracts of land), and the northern parts of North America; (2) the African fauna, allied to the preceding; (3) the South Asiatic or Indian; (4) the Australian and Polynesian, allied to the Indian; and (5) the American fauna, distinguished by its exceeding richness.

ca- BUTTERFLIES.—Linnæus included all butterflies under the single genus *Papilio*, but later writers have divided them into several well-defined families, and into numerous genera. The largest and most magnificent species belong to the *Ornithoptera* or "Bird-winged Butterflies," a genus of *Papilionidæ*, whose wings, measuring fully 7 inches across, are of a velvety black and brilliant green colour, the latter in such species as *Ornithoptera crœsus* being replaced by fiery orange, while the body is golden, and the breast crimson. They are distributed over the islands of the Malay Archipelago, reaching, according to Mr Wallace, their maximum of size and beauty in the Moluccas. The *Papilios* are a closely allied group, smaller in size but equally brilliant in the colour and form of their wings. They are exceedingly numerous and are widely distributed over both hemispheres. One species only is found in Britain, the handsome Swallow Tail (*Papilio machaon*) (Plate XXVII. figs. 1, 2), formerly abundant in many parts of England, but now confined to the fen districts of Cambridgeshire, Norfolk, and Huntingdon. When alarmed the larvæ of this and of other species of Papilios protrude from the upper part of the neck a soft forked horn that usually diffuses a penetrating and unpleasant odour. One of the most elegant of exotic species is the Malayan *Papilio memnon*, with black and blue wings, 6 inches in expanse, and with the edges of the hind pair gracefully scalloped. This butterfly, though common enough in collections, has recently gained additional interest from the fact, discovered by Mr Wallace, of the remarkable variety in the form of the females, a variety which has led to their being described under several specific names. In one group the females resemble the males in shape, though differing greatly—as many female butterflies do—in colour. In another group they differ both in colour and in the form of the hind-wings. These, Mr Wallace says, are "lengthened out into large spoon-shaped tails, no rudiment of which is ever to be perceived in the males or in the ordinary form of the females." He also found that in shape and colouring those tailed females when on the wing, closely resembled another butterfly belonging to a different section of the same genus, *Papilio coön*, which he considers is thus mimicked by the erratic females of *Papilio memnon*. Strange to say both forms of female are produced from the eggs of either form. The genus *Parnassius*, which seems peculiar to the Alpine or subalpine countries of Europe and the North of Asia, belongs also to the *Papilionidæ*. One species, *Parnassius apollo* (Plate XXVII., fig. 3), has semi-transparent wings, spotted with black and vermilion, and is common in most of the mountain ranges of Europe, where it forms a very striking object. The Brimstones (*Gonepteryx*), the Clouded Yellows (*Colias*, Plate XXVII. fig. 4), and the White Butterflies (*Pieris*, Plate XXVII. fig. 6), many of which are abundant in Britain, and the larvæ of which in most cases make great havoc among garden vegetables, belong to the family *Pieridæ*. That the caterpillars of this group are not fatal to the very existence of certain of our most useful vegetables is due solely to the ravages of the ichneumon flies, the larvæ of which are parasitic upon these caterpillars, to such an extent that in every hundred larvæ of the common Cabbage Butterfly, there are probably not more than two or three entirely free from the ichneumon fly (*Microgaster glomerata*), and few caterpillars so attacked ever reach maturity. The species belonging to the family *Nymphalidæ* have only four legs fitted for walking, the anterior pair being rudimentary. They include the majority of the showy butterflies of temperate regions, as the Peacock Butterfly (*Vanessa io*, Plate XXVII. fig. 9), conspicuous from the "eyes" on the upper surface of its wings. The brilliant colouring of the upper surface is in marked contrast to the sombre hues of the under, which give it when resting on the branch of a tree the appearance of a dried leaf, and so is to a considerable degree protective. The Fritillaries (*Argynnis*, Plate XXVIII. fig. 2) have the under surfaces of the wings ornamented with shining silvery disks, and, except a few tropical species, are the only butterflies which have the under surface more gaily coloured than the upper. The Purple Emperor (*Apatura iris*) is one of the largest and most striking of British species. It is a powerful flyer, frequenting the tops of the highest trees, and is thus difficult of capture unless when brought near the ground by the attraction of some putrid carcase. To the same family belongs *Nymphalis jasius* (Plate XXVIII. figs. 7 and 9), one of the most beautiful of European species. The *Heliconidæ* (Plate XXVII. fig. 7) are a family of South American butterflies, so numerous both in species and in individuals, and of such showy colours on both surfaces of the wings, as to form, says Bates, "a feature in the physiognomy of the forest compensating for the absence of flowers." Their wings are long and narrow, they fly lazily, and might thus be supposed to be specially liable to the attacks of insectivorous animals. As already stated, such is not the case, these insects being apparently protected by the nauseous character of their juices. It is this group which is chiefly mimicked in South America, finding imitators in several species of *Leptalis*, a genus of butterflies belonging to the family *Pieridæ*, also in several species of *Erycinidæ*, and in no fewer than three genera of day-flying moths all belonging to edible groups. The family *Morphidæ* (Plate XXVIII. fig. 8) contains the largest and most splendid of the South American butterflies. Their wings, often 7 inches in expanse, are generally of a brilliant metallic blue, which, as the insect flies, flashes in the sunlight so as to be visible, it is said, a quarter of a mile off. They are found most abundantly in forest glades, through which they sail, only flapping their wings at considerable intervals at a great height, "seldom," says Bates, "descending nearer the ground than 20 feet." The *Satyridæ* (Plate XXIX. fig. 6) are found in every quarter of the globe, and seem equally at home on open plains, in forests, and on the slopes of mountains. Their larvæ feed chiefly on grass, and have the almost unique habit of remaining concealed by day and of coming forth at night to feed. The Marbled White (*Arge galathea*) is the species oftenest met with in Britain. The *Hetairæ* of Brazil, the wings of which are partly-transparent, belong to this

family. One of these, *Hetaira esmeralda*, says Bates, "has one spot only of opaque colouring on its wings, which is of a violet and rose hue; this is the only part visible when the insect is flying low over dead leaves in the gloomy shades where alone it is found, and it then looks like the wandering petal of a flower." The *Hesperidæ* or Skippers (Plate XXIX. figs. 13 and 15), so called from their jerky hesitating mode of flight, show, in the thickness of their bodies, the only partially erect way in which they hold their wings when at rest, and the enclosure of their pupa in a cocoon, a distinct approach to the other great division of the *Lepidoptera*—the moths.

sification of moths.

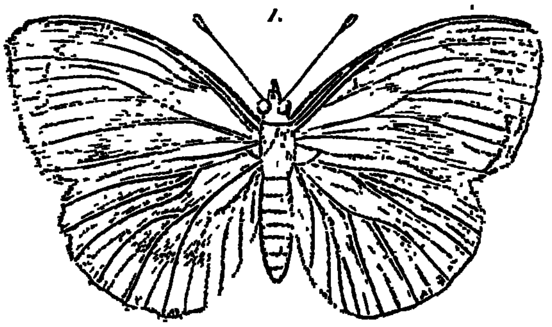
MOTHS.—The vast collection of species included under this term form eight principal groups, divided into numerous families.

1. The *Sphingina* or Sphinx Moths (Plate XXX. figs. 5 and 6), so called from the curious habit which the larvæ have of raising the anterior segments of their bodies, and remaining motionless in this position for hours, thus bearing a fanciful resemblance to the fabled Sphinx, are for the most part crepuscular and day-flying. They are also known in the type family as Hawk Moths from the strength and velocity of their flight. In common with the vast majority of moths they are furnished with a spine or strong bristle on the anterior margin of the inferior wings, which being received by a process of the under surface of the superior pair, maintains them in a horizontal or somewhat inclined position in repose. They are also usually provided with a greatly elongated tongue, with which they sip their food from flowers, and some species have the power of producing a humming sound. To this group belong the clear-winged moths, *Sesiidæ* (Plate XXX. fig. 12) and *Ægeriidæ*, all day-fliers, and looking more like the bees, wasps, and ichneumons which they are supposed to imitate, than moths; also the family *Uraniidæ* (Plate XXIX. figs. 9 and 14), the species of which are among the most brilliant of *Lepidoptera*,—their wings being of velvety black, relieved by numerous bars of golden green, and the inferior pair prolonged into an elegant tail, closely resembling the same appendage in many of the Papilios. They are all day-fliers, and this, together with their gay colouring and airy forms, led to their being at first classed among butterflies, a position which fuller acquaintance with them in the larva and pupa stages showed to be untenable. The typical species occur in tropical America, where they fly with amazing rapidity and perform annual migrations. The Death's-Head Moth (*Acherontia atropos*) is the largest of European Sphinges, and owing to the peculiar squeaking sound which it utters when alarmed, the death's-head-like markings on the upper surface of its thorax, and its sudden appearance in districts where it may not have been noticed for years, it has for centuries been an object of superstitious dread to the uneducated. Its beautifully marked larvæ feed upon the leaves of the potato, and bury themselves in the ground preparatory to undergoing metamorphosis. The Death's-Head is fond of honey, in search of which its instinct leads it to enter hives, the inmates of which do not attempt to drive it out by means of their stings, but make every endeavour to raise a waxen wall between the moth and their food stores. It is widely distributed over Europe, Asia, and Africa, while closely allied, but still larger forms occur in Australia.

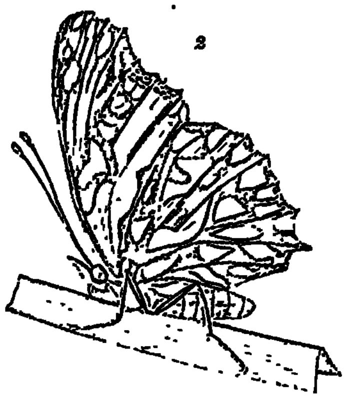
2. The *Bombycina* (Plate XXX. figs. 14, 20-25) are nocturnal moths, with the organs of the mouth in many cases so atrophied as to be unfit for use. These live but a few days, during which the male seeks the female and the latter deposits her eggs. They include the silkworm moths, so important to man from the silken cocoons in which they enclose their pupæ. The silk-producing species are very numerous, but only a few of them have as yet been turned to useful account. The chief of these are the common Silkworm Moth (*Bombyx mori*), a native of China, where its cocoons appear to have been utilized by man from time immemorial. During the 6th century it was introduced into Europe, where it soon flourished wherever the mulberry tree, the leaves of which are the sole food of the silkworm, abounded. On these the larvæ feed for thirty days, after which they begin to spin an oval cocoon of a close tissue of the finest silk, usually of a golden yellow colour, but sometimes white, and which when unravelled forms a continuous thread 1100 yards long. In order to obtain a fresh supply of eggs, the silkworm breeder allows a few of the pupæ to develop into moths; and such is the change wrought upon this species by centuries of domestication that, it is said, they rarely if ever attempt to use their wings. They pair, and the female at once settles on the leaves provided for her, where she deposits her eggs and dies. The Arrindy Silkworm (*Attacus cynthia*), so called from the native name of the castor-oil plant on which its larvæ feed, is a native of India. The cocoon is very large, but the thread is too fine to be readily wound off, and it is therefore usually carded, the yarn being woven into a coarse silk cloth of great durability. The Tusseh or Tussur Moth (*Antheræa mylitta*) is also a native of Upper India, occurring abundantly in the jungles, where its cocoons, so concealed by the leaves as only to be detected by the presence of the dung of the larvæ on the ground, are collected. The Tusseh silk is darker and coarser than that of the common silkworm, but resembles it in being readily wound off. In China there are two oak silkworms from which a coarse silk is obtained, used for the clothing of the Chinese poorer classes; but the most important of the oak-feeding species is the Yama-maï (*Antheræa yama-maï*) of Japan, the silk produced from which was, at least until lately, reserved for the use of the Japanese imperial family. This moth is a beautiful insect, about 6 inches across the wings, of a brilliant golden-yellow colour, with a transparent spot or "eye" near the centre of each wing. Its cocoon is nearly as large as a pigeon's egg, and is of a silvery white within, although externally of a yellowish green. In 1861 it was introduced into France, where it now flourishes, and there is good reason to believe, from the nature of its food and its hardiness, that the Yama-maï may yet be profitably reared in Great Britain. *Tropæa luna*, which feeds upon the liquidambar trees in the southern parts of the United States, with wings of a lemon colour, each with a "transparent eye," and the hind pair prolonged into an elegant tail, is one of the loveliest species of *Bombycina*. Its cocoon is formed of the finest silk. Other well-known forms are the Eggars (*Lasiocampa*, Plate XXX. fig. 26); the Processional Moth (*Cnethocampa processionea*), so called from the habit its caterpillars have of congregating in companies of several hundreds, and of marching to their feeding-grounds in regular columns; the Vapourers (*Orgyia*, Plate XXXI. figs. 2, 3, 4), whose females being almost wingless deposit their eggs on the outside of their cocoons, and the Psyches (*Psychidæ*), whose females in many cases have neither wings, legs, nor antennæ, and never leave the tubes in which they have passed the larva and pupa stages.

3. The *Noctuina* (Plate XXXI. figs. 9 and 14) form an exceedingly large group of nocturnal moths, although even here there are a few exceptional instances of day-flying species. They are distinguished by their stout bodies and narrow forewings, under which when reposing they conceal the inferior and in many cases more brightly-coloured pair. The majority of the species are small and dull in their colours, while a few are among the largest of known insects—the Great Owl Moth of Brazil (*Erebus strix*) measuring nearly a foot from tip to tip of its wings.

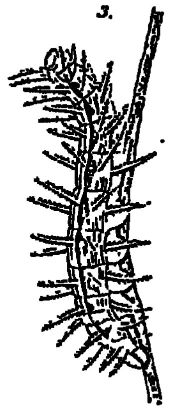
4. The *Geometrina* (Plate XXXI. figs. 13 and 15) in the



Vanessa callithea.

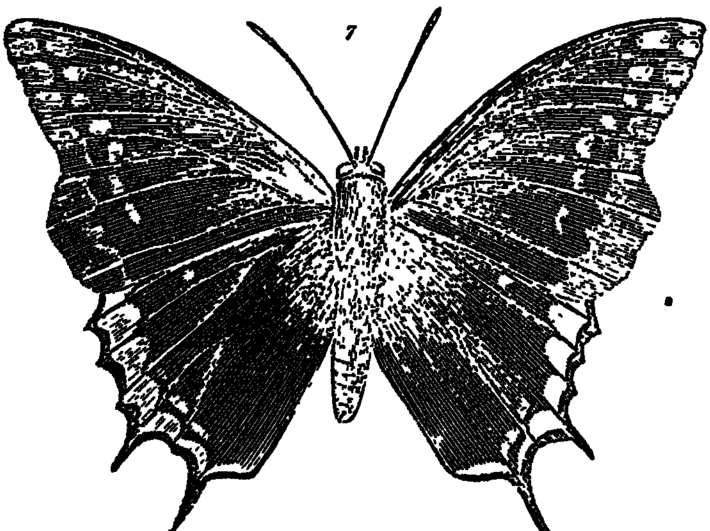


Argynnus moneta
(Silver-spotted Fritillary)

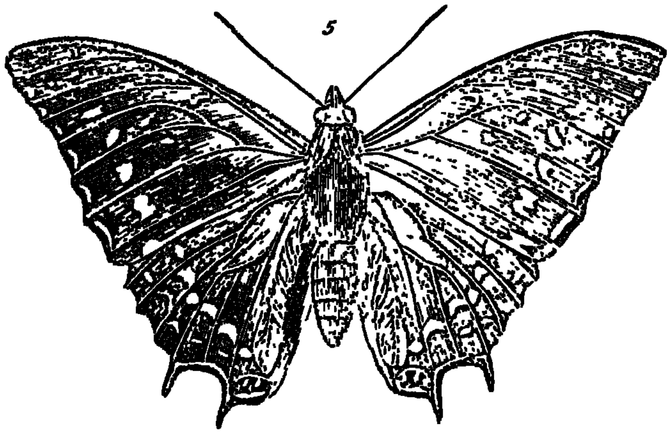


Larva of
Argynnus paphia
(Silver washed Fritillary)

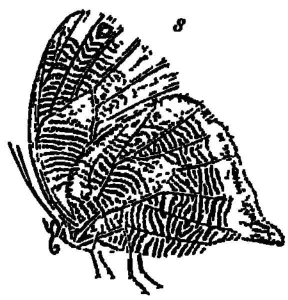
Larva of
Nymphalis ilia



Nymphalis Jasius



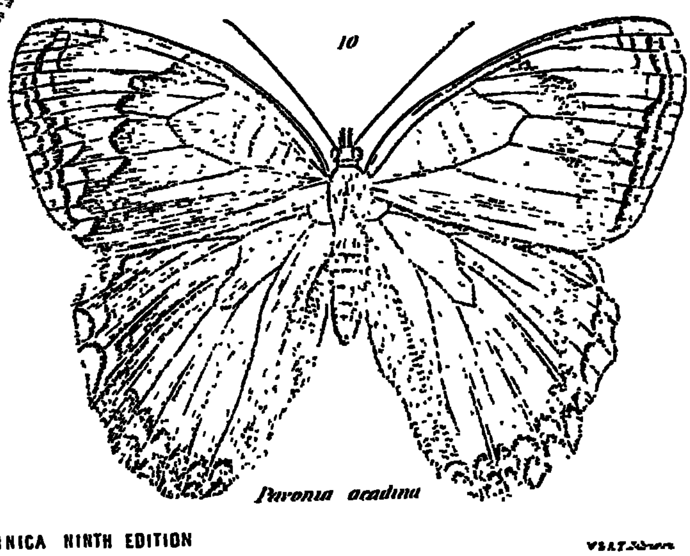
Nymphalis ethea



Morpho actorion

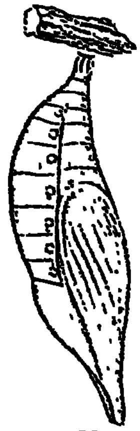
Chrysalis of
Nymphalis ilia

Nymphalis Jasius



Paronia acadina

1.

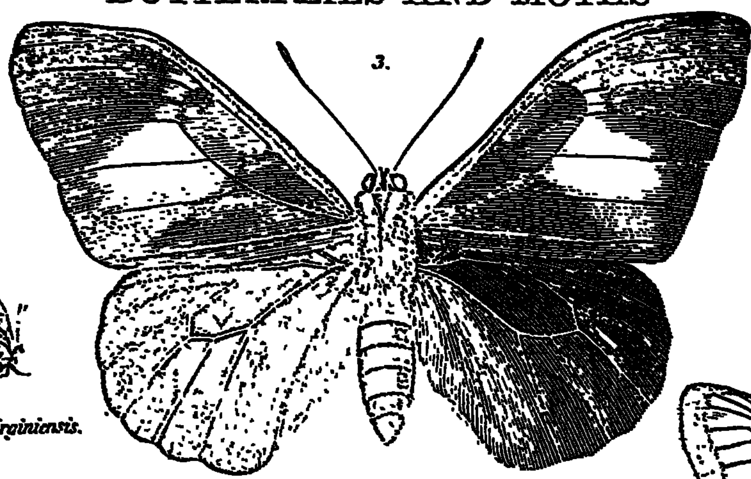


Chrysalis of Morpho phidippus.

2.

Erycina virginiensis.

3.

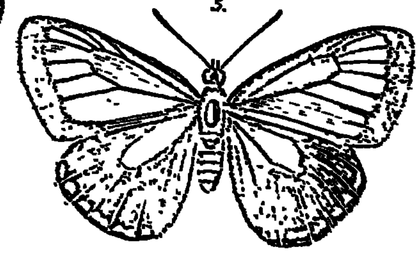


Brassolis astyra.

4.

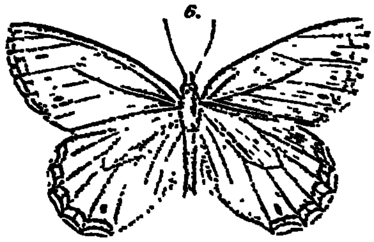
Erycina virginiensis.

5.



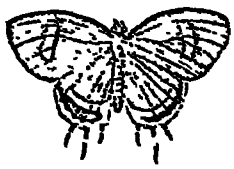
Eumenia toxea.

6.



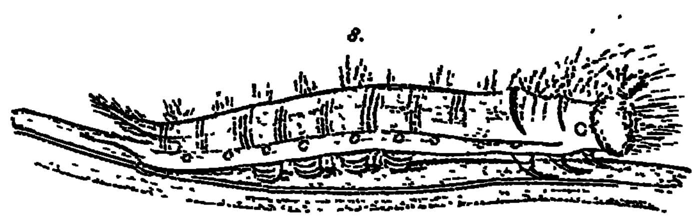
Satyrus Balder.

7.



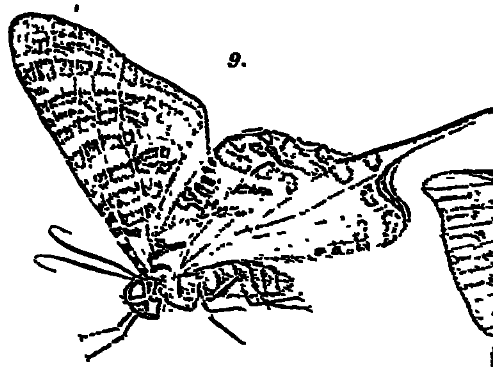
Zephyrius amor.

8.



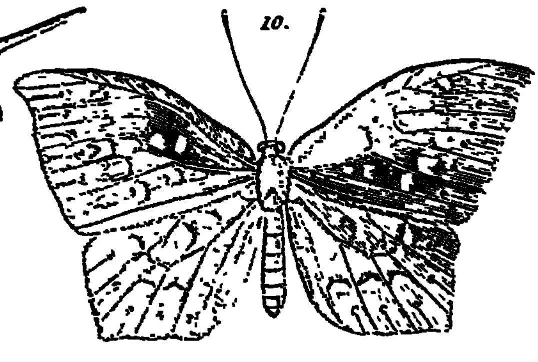
Larva of Morpho phidippus.

9.



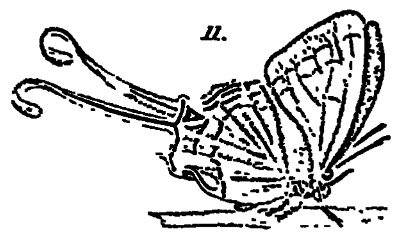
Urania Boisduvalii.

10.



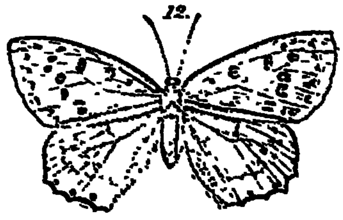
Eurybia carolina.

11.



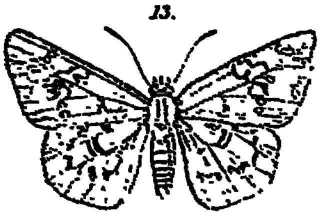
Myrina Jaffra.

12.



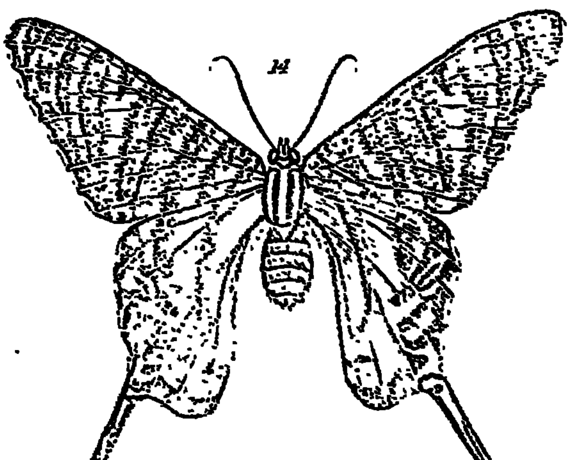
Polyommatus Thoe.

13.



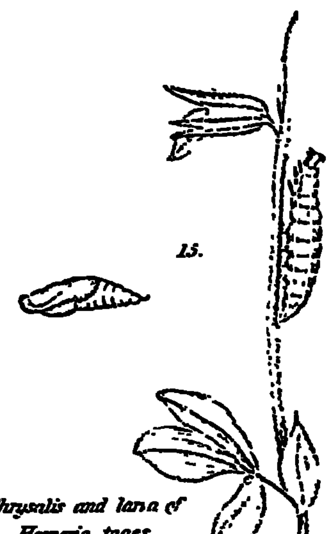
Hesperia sabadius.

14



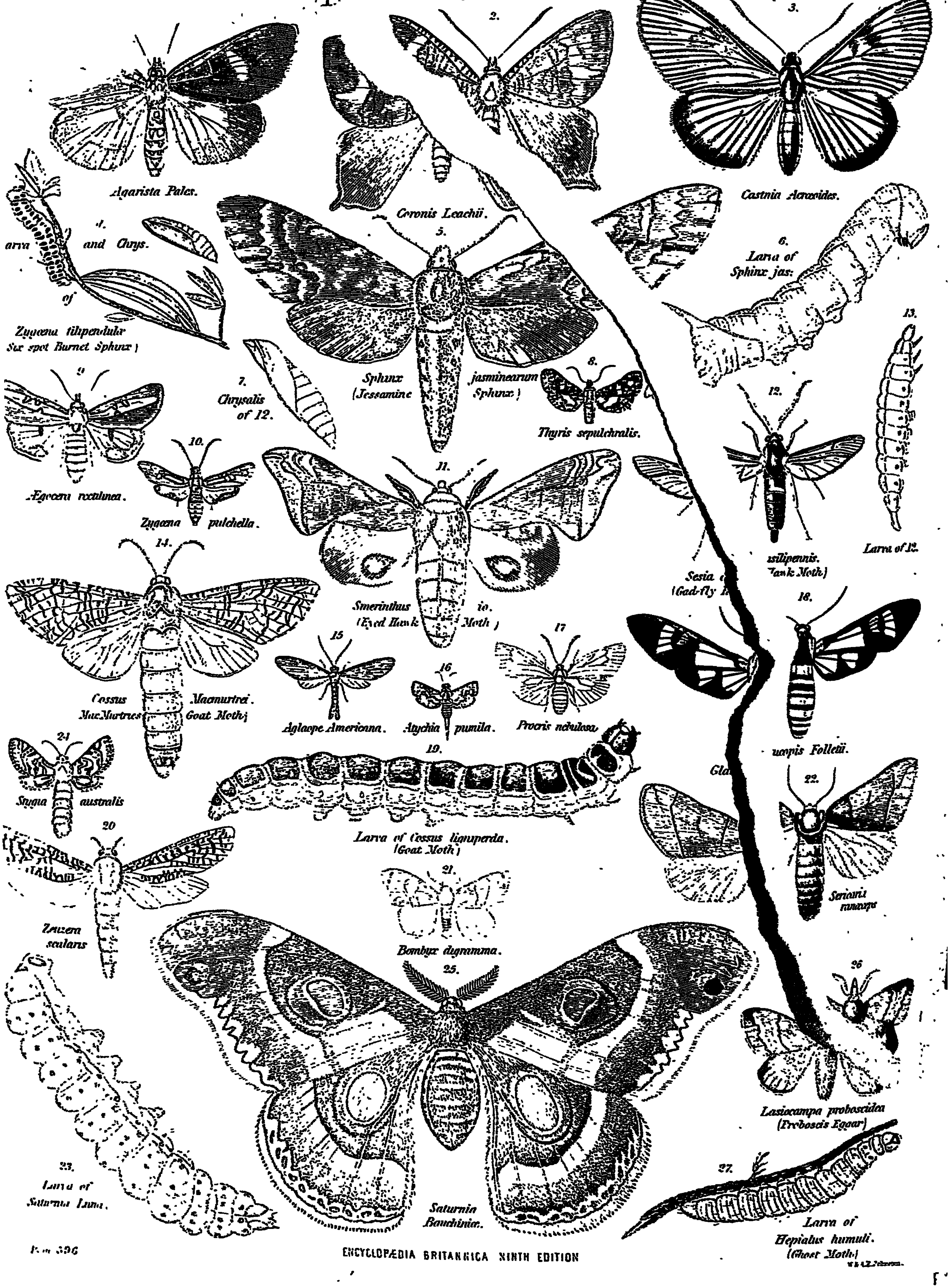
Urania Boisduvalii.

15.



Chrysalis and larva of Hesperia tages (Dingy Skipper)

MOTHS.


Agarista Pales.
2.
Coronis Leachii.
3.
Castnia Acraeoides.
4.
and Chrys.
Zygaena filipendulae
Six spot Burnet Sphinx
5.
Sphinx jasminearum
(Jessamine Sphinx)
6.
Larva of Sphinx jas:
7.
Chrysalis of 12.
8.
Thyris sepulchralis.
9
Aegocera rectilinea.
10.
Zygaena pulchella.
11.
Smerinthus io.
(Eyed Hawk Moth)
12.
Sesia
(Gad-fly
13.
Larva of 12.
14.
Cossus Macmurtrei.
MacMurtrie's Goat Moth
15
Aglaope Americana.
16
Atychia pumila.
17
Procris nebulosa.
18.
19.
Larva of Cossus ligniperda.
(Goat Moth)
20
Zeuzera scalaris
21.
Bombyx digramma.
22.
23.
Larva of Saturnia Luna.
24
Synygia australis
25.
Saturnia Bauhiniae.
26
Lasiocampa proboscidea
(Proboscis Eggar)
27.
Larva of Hepialus humuli.
(Ghost Moth)

larval condition have only four prolegs, the usual number being ten, and in moving these are brought close up to the last pair of thoracic limbs, thus giving the caterpillar a looped appearance, hence the term "loopers" usually applied to these moths; they then hold on by the prolegs, and releasing those in front carry the body forward until the arched appearance is gone. They thus move by an alternate process of looping and straightening their bodies. The larvæ of Geometers have also the curious habit of fixing themselves by their hind feet to the branch of a shrub, throwing the remainder of their bodies out, and remaining motionless in this position for hours, thus exhibiting an enormous amount of muscular energy. They are all protectively coloured, and in the attitude just described so resemble the surrounding twigs as to be readily mistaken for them. Geometers are to be found in sunshine and by night, in midsummer and at midwinter, the Early Moth (*Hybernia rupicapraria*) being caught in January.

5. The *Pyralidina* (Plate XXXI. figs. 17, 19, 20, 23) are a group of small moths readily distinguished by their long slender bodies and large forewings. One of these, *Pyralis vitis*, is very destructive to vines, and another, *Pyralis farinalis*, feeds upon meal and flour. The *Galleridæ*, a family of Pyralidine moths, deposit their eggs in the hives of bees, where the caterpillars, enclosed in silken cases, devour the wax; but the *Hydrocampidæ* (Plate XXXI. fig. 12), which also belong to this section, are probably the most wonderful of all Lepidopterous insects, their larvæ being aquatic, living and feeding in the water, and many of them breathing by gills similar to those of caddis-worms.

6. The *Tortricina* (Plate XXXI. fig. 16) include a great number of small moths exceedingly injurious to orchard and other trees. They are known as "leaf-rollers" from the habit which most of their larvæ have of rolling up the leaves on which they feed, and thus forming a shelter for themselves. The Green Tortrix (*Tortrix viridana*) occurs in the larva state on the oak, to which it often does great injury by stripping the trees of their leaves in the month of June. Throughout Southern Europe the vine is liable to the ravages of another species, *Œnectra pillariana*, while few of our fruit trees are exempt from the occasional attacks of some species or other of the *Carpocapsidæ*, the fruit-eating family of this group.

7. The *Tineina* (Plate XXXI. figs. 21, 24, 25) contain the smallest of the *Lepidoptera*, and are best known as clothes moths. These clothe themselves at our expense in the warmest woollen garments, which they traverse in all directions, leaving behind a gnawed and worn-out path, so thin and bare as to yield to the slightest pressure. They also destroy furs, hair, feathers, and many other articles of domestic economy, and are the exterminating pests of zoological museums. To them we no doubt owe the destruction of the most perfect specimen of the Dodo known, which was once preserved in the Ashmolean Museum of Oxford. By means of their maxillæ these little larvæ shear down the surface of various substances, and uniting the particles by means of their glutinous silk, they thus form protecting habitations, which partake of the nature of the woollen or other stuffs on which the foresight of their parents has placed them. When they themselves increase in bulk, so as to find their abodes as inconvenient as a strait waistcoat, they split them down the middle, and interpose a piece proportioned, no doubt, to their expected as well as actual increase. They add to the length also by ...h materials to the anterior end. The *Tinea granella* ...s in granaries, where it forms an abode for itself by ...eloping several grains in a silken web. These it after...ds eats.

The insects of the remaining group, *Pterophorina*, are remarkable from the peculiar conformation of their wings. Each of these organs is split longitudinally into several branches, all of them delicately fringed. In the genus *Pterophora* (Plate XXXI. fig. 26) the fore wings are divided into two, and the hind wings into three branches; while in *Orneodes* (Plate XXXI. fig. 27) each wing is split into six, and these when the insect is at rest are folded together after the manner of a fan.

Collectic and pre- servatioı

COLLECTION AND PRESERVATION OF LEPIDOPTERA.— Butterflies affect special localities with which it is well for the collector to make himself acquainted. A suitable hunting ground having been selected, the following apparatus is necessary:—a bag-net made of gauze or some equally light material, with a wooden or metal ring and a handle, which may also be used as a walking-stick, for capturing the specimens; pill boxes into which to transfer them from the net; and a wide-mouthed glass stoppered bottle, into which about forty leaves of the common laurel, bruised and cut into shreds, have been previously put. Exposure for a short time to the fumes arising from these shreds will cause the death of the inmates of the pill boxes. They may also be readily killed by pressing the thumb-nail against their thorax. For "setting" Lepidoptera, which if possible should be done before the insect stiffens, entomological pins are required, and these should be gilt in order to prevent the appearance of verdigris at the point where the pin enters the specimen; also a setting-board, with an upper layer of cork, and having a groove in which to lay the body of the insect; and small triangular strips of cardboard known as braces with which to set the wings. The process of drying should not be artificially hastened, as by exposure to heat the wings are certain to warp and the body to shrivel. Should the insect have stiffened before setting, or have been badly set, it can readily be softened again by placing it, as is done in the British Museum, in a shallow earthen vessel containing a layer of damp sand, and covering it with a close-fitting lid until sufficiently soft for resetting. Day-flying moths must be sought for in much the same way as butterflies, while nocturnal species may be regularly met with on the sallow, the honeysuckle, the lime-tree, and the ivy, when these are in flower; and when these and similar natural sources fail, the moth-collector has in *sugar* and *light* two admirable devices for securing specimens. A quantity of the coarsest brown sugar reduced by the addition of beer and water to a syrup, and to which a little rum is added as required, is applied with a brush to the sheltered aspect of the trunks of trees on the outskirts of woods or in the neighbourhood of heaths. At nightfall the collector, lamp in hand, visits the sugared locality, and if the evening be favourable, that is, if it be warm and dull, he is almost certain to have his pains rewarded by an abundance of specimens, chiefly belonging to the *Noctuina*. Moths, it is well known, are readily attracted by light, and in a country or suburban house, in the vicinity of trees, a lamp placed outside an open window, which is sheltered from the wind, with another lamp in the interior of the room, will, if the night be close and dark, be almost certain to attract numbers of moths. Mr Wallace adopted this plan while collecting in Borneo, and he states that in twenty-six nights he collected 1386 moths, "but that more than 800 of these were collected on four very wet and dark nights." In towns moths may often be caught flying about lamp-posts. In preserving the larger moths, especially the *Sphingina*, it is necessary to slit up their stout bodies and remove the contents, replacing these with wadding or paper. The drawers of cabinets containing *Lepidoptera* should be provided with a layer of cork and then papered, with a small bag of camphor attached to a corner to ward off the attacks of the dust-lice, or "mites" as they are usually, but incorrectly, called, the

presence of which is made known by the appearance of a fine powder lying underneath the infected specimens. Insects in this condition should be thoroughly soaked in a solution of spirits of wine and camphor. The appearance of grease on thick-bodied moths is by no means uncommon, but may be removed by dipping the insect in spirits of turpentine and embedding it in calcined magnesia till dry The collector should be careful to keep a register of all his specimens, giving the localities where they were found, and recording any observations that may have been made at the time on their food, habits, &c. A small ticket attached to the pin of each specimen, and bearing its number in the register, is the best way of connecting the specimens in the cabinet with the entries in the register (J. GI.)

BUTTMANN, PHILIPP KARL (1764–1829), a German philologist, was born at Frankfort-on-the-Main in 1764. He was educated at the gymnasium in his native town and at the university of Göttingen. In 1789 he obtained an appointment in the library at Berlin, and for some years he edited *Spener's Journal*. In 1796 he became professor at the Joachimsthal Gymnasium, a post which he held for twelve years. In 1806 he was admitted to the Academy of Sciences, and in 1811 was made secretary of the Historico-Philological Section. He died in 1829. Buttmann's writings gave a great impetus to the scientific study of the Greek language, and his grammar is still a work of value. The first edition of the *Griechische Grammatik* appeared in 1792, and in 1863 the book was in its 21st edition. It has been translated into English. The *Lexilogus*, a valuable study on some words of difficulty occurring principally in the poems of Homer and Hesiod, was published in 2 vols., 1818–25. The English translation by Fishlake has passed through five editions Buttmann's other works were *Ausführliche Griechische Sprachlehre*, 2 vols., 1819–27; *Mythologus*, a collection of essays, 1828–9; and editions of some classical authors. Of these last the most important are *Demosthenes in Midiam*, 1823, and the continuation of Spalding's *Quintilian*.

BUTTON, from the French *bouton*, a small piece of metal or other material used to connect different parts of a garment together by means of a button-hole, and also used for ornamentation. These apparently insignificant articles have produced a great alteration in our style of dress, for without them it would have been impossible to have reduced the flowing robes of our forefathers into our present simple costume. By this process we have lost the picturesque, as far as our garments are concerned, but have gained in compactness and utility. Indeed, the occupations of the present age could not be carried on in the togas and dresses of ancient times. The button manufacture did not assume any special form until towards the close of the reign of Elizabeth. In paintings, commencing with the 14th century, studs or buttons appear as ornaments on the dresses of both sexes; but they were ornaments merely, being drawn without button-holes, and placed where they could serve no practical purpose. They are in general represented as of gold or ivory. At the commencement of the 17th century the trade had greatly increased. but the making of buttons by the needle seems to have been the principal method.

Matthew Boulton, who became the senior partner in the afterwards celebrated firm of Boulton and Watt, as early as 1745, introduced great improvements in the manufacture of buttons, particularly inlaid and steel. When the Soho Works were established near Birmingham, one of the departments was occupied in making steel buttons with facets, that produced a hundred and forty guineas the gross. Gilt buttons came into fashion shortly after the accession of George III. A large shipping trade in buttons was then carried on with the Continent and America, and the workmen's wages at Birmingham averaged from £2 to £4 per week. John Taylor, originally a cabinetmaker, appears to have had a principal hand in promoting improvements in this industry at that time, as far as gilt, plated, and lacquered buttons are concerned. The value of those turned out weekly in his establishment is said to have been about £800. Ralph Heaton improved the making of shanks, a separate branch, shortly before the commencement of the present century.

The metal button trade was in a very flourishing condition, when, indirectly, Lord Nelson may be said to have been the means of overthrowing it. The late B. Sanders was in easy circumstances in Denmark when he was ruined by the bombardment of Copenhagen under our great naval commander. Sanders then came to Birmingham to seek such competence as energy and perseverance could afford. He started in the button manufacture, at first in a small way, introducing a covered button made of cloth or lasting, with an iron shank. His son, of the same name, invented a flexible shank button, that is, one with a tuft of canvas protruding from the back instead of a shank, through which the needle could pass in any direction. It was patented in 1825 and had an enormous sale. The Sanders took out another patent for a similar button covered with silk. A fancy silk button with a central ornament was patented by William Elliott in 1837, which had a great run, so much so that sixty looms were employed in London in making the special material required; and Elliott secured a fortune, although his patent was contested and many imitations were started. But all these kinds of buttons were found to wear on the edges, to remedy which John Chatwin patented a corded edge button. It is said that horn buttons were used as early as 1801, but we find from old Birmingham directories that there were horn-button makers as far back as 1777. At the former period the commonest qualities were 5½d. per gross. Hutton in his *History of Birmingham* refers to "our grandmothers" wearing horn buttons nearly the size of a crown piece. The hoof or horn button is cut into form and dyed and pressed into beautiful designs. This great improvement, however, appears to have been effected by M. Emile Bassot of Paris, who introduced important changes resulting in material progress. The manufacture is still prosecuted in England, but it is of secondary importance.

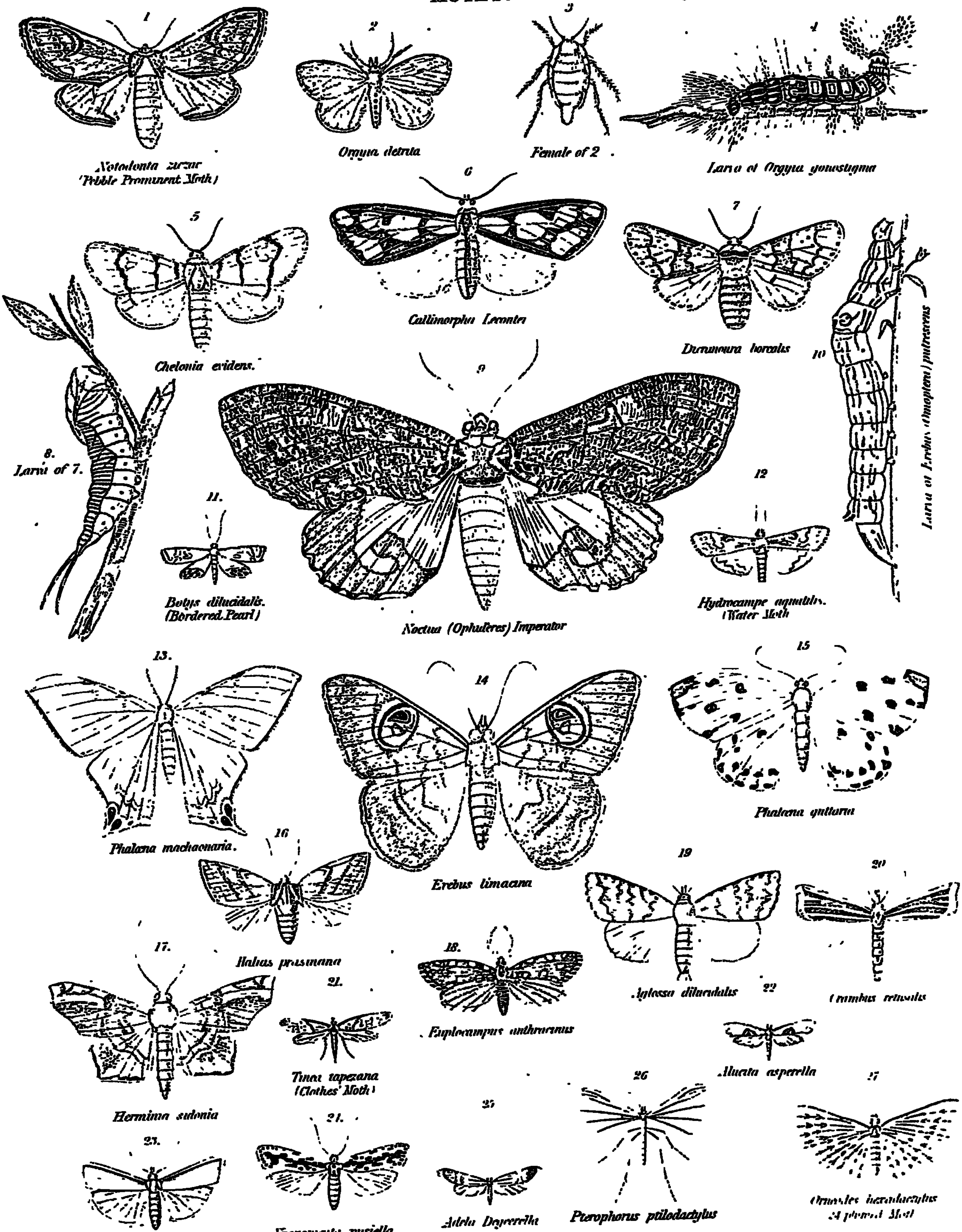
The materials of which buttons are made are as various as their forms. Gold, silver, and other metals, glass, porcelain, horn, bone, india-rubber, mother-of-pearl, and other nacreous productions of shell-fish,[1] various woods, vegetable ivory, &c.,[2] are employed; and for covered buttons, lasting, brocade, twist, velvet, silk, mohair, &c. The Birmingham *Directory* for 1784 mentions paper buttons; and, according to the same authority, a button was produced by "an artist of eminence," which was inlaid with divers other metals; it was first attempted about sixty years previously; and then, "though in no respect so complete as at present, met with great and merited encouragement." Buttons have been often expensively jewelled, and the gold and silver are plain or ornamented, sometimes resembling drops in filigree-work. There was one in use in England about the middle of the last century

[1] The shells are brought from various parts of the world, and vary considerably in price. The white-edged Macassar are the best; the yellow-edged Manilla the next. Those from the Persian Gulf and Red Sea vary much in value, which depends upon the purposes to which they can be applied. Those from the Pacific are beautiful, but, being generally dark in colour, their value is much affected by the turns of fashion. The "Panama shells" are the least valuable, and are generally only used for inferior sorts of buttons.

[2] Vegetable ivory is not very suitable for buttons; it is too soft, and the unavoidable waste in manufacture renders it expensive.

BUTTERFLIES AND MOTHS

MOTHS.



formed of polished brass and ruled with such fine lines that light was reflected in prismatic colours. Some buttons have fetched enormous prices, even when made of what is now a common material. Mother-of-pearl buttons have been sold at a guinea each. In 1790 Henry Clay of Birmingham patented a method of manufacturing buttons of slate or slit stone; and, in 1800, Joseph Barnett introduced a button with two shanks or other fastenings on one button.

Such was the origin of the button industry in England, and other nations have not been behind. The *Scientific American* gives the following account of its commencement in the United States:—

"The first manufacturer of buttons in this country was Samuel Williston. While he was dragging along as a country storekeeper,—his eyes having failed him while studying for the ministry,—his wife bethought her that she could cover by hand the wooden buttons of the time, and thus earn an honest penny. From this the couple advanced in their ambition until they had perfected machinery for covering buttons, the first employed in this country. From this sprang an immense factory, and then others, until Samuel Williston made half the buttons of the world. His factories are still running at Easthampton, coining wealth for the proprietors. . . . . He is now (1871) between seventy and eighty years of age, is worth five or six millions, and has given four hundred thousand dollars to Easthampton for a seminary and for churches; two hundred thousand dollars to South Hadley Female seminary; and two hundred thousand dollars to Amherst College, besides lesser gifts."

The factories of Samuel Williston & Co., above referred to, at Easthampton, Massachusetts, were established about the year 1848, and give employment to about 250 operatives. The annual cost of the materials used is estimated at $75,000, and the value of the produce exceeds $200,000. The button manufacture is also carried on extensively in New York and Philadelphia, and at Waterbury (Conn.). Buttons are also imported extensively. There are five importers in New York (1876). Joel Hayden of Haydenville began to make flexible buttons in the States in the year 1834.

Other countries have not been backward in this branch of industry. Bohemia, particularly at Prague and the neighbouring towns, is the great seat of the glass button manufacture, and great numbers are made in France. The porcelain button manufacture has been taken possession of by France, Minton and Co., the celebrated Staffordshire firm, who worked the invention of R. Prosser of Birmingham, having been driven out of the field by the good work, attended by greater cheapness, of the foreign makers. There is one factory at Milan, and great numbers of the cheaper kinds of buttons are made in the Rhenish provinces of Prussia. Vienna has suppressed the competition of English makers in some kinds of pearl buttons. Its operations in this branch are of a most extensive character, quite rivalling those of Birmingham.

"Button making," says the Birmingham *Directory* for 1777, "was originally a very tedious and expensive process. The button consisted of one solid piece of metal; and the ornaments upon the face of it were the work of an engraver. To obviate this, the press, stamp, and engine for turning the moulds were invented. This led to other improvements, the bones and hoofs of animals were introduced into the manufacture; by these various means the prices of buttons were reduced."

In the manufacture of covered buttons the sheet-iron is first scaled by the use of acids, and then cut into proper shape and size by a machine. The neck or collet of the button is japanned after having been stamped and cut. The hollow between the neck and shell is filled in with brown paper or button board. When the parts are put together they are pressed, which brings them into shape and consolidates them.

It would be impossible in the space that could be devoted to the subject here, to describe in detail the various modes in which the numerous forms of buttons are manufactured,—especially as it would require elaborate illustration. We must, therefore, confine ourselves to noticing some of the special and more recent patents; referring the reader to works where he can obtain such further information as he may require. In 1840 Joseph Parkes took out a patent for improvements in the manufacture of covered buttons made by dies and pressure, by the application of horn as a covering material. Harris's patent for improvements in horn buttons and their dies was obtained in April 1841. This invention related to applying flexible shanks to horn buttons, a mode of ornamentation by inlaying the front surfaces, and also gilding or silvering their surfaces, and to a mode of constructing dies so as to facilitate the process of engraving, the die being also so formed that the horn or hoof employed could not be expressed outside the circumference of the button. Hugh Willoch's patent, dated 5th May 1874, related to a button with a removable head to enable the shank to pass through the button hole. The head is hollow and is partly filled with caoutchouc. It is perforated to admit the shank top, a short transverse bar which, on being turned one-fourth round, falls into an internal groove in the material of the button head, and is retained in that position by the elasticity of the india-rubber. Empson and Palmer's patent, dated 4th July 1874, refers to improvements in linen buttons, and is also applicable to buttons covered with other fabrics. They are composed of a front and back shell, with a bar formed across the face of a raised concentric circle from the back shell (which is all the metal that need be visible in the finished button), the shells permitting ample room for the covering fabrics to be gathered in and held between them. They are considered to resist the injury common to linen buttons during the processes of washing, mangling, and ironing. Tylor's patent, of 13th July 1874, relates to polishing ivory, bone, and similar buttons in a revolving drum with revolving brushes inside. Harrison's invention (8th September 1874) consists in arranging the piercing tools, so that the thread holes for the buttons are made in the pierced metal in front of the shaping and cutting-out tools, and the metal around the groups of piercings is shaped or "domed," and cut out. The result is that at each descent of the compound tool three or more groups of the thread holes are pierced in the sheet metal, and three or more finished buttons are made. The piercings in the sheet metal made by the last descent of the compound tool form the thread holes of the buttons made by the next descent of the said compound tool. When the thread-holes of the button are made in a central depression, a shaping tool for making the said depression is placed between each piercing tool and cutting-out tool. This invention is also applicable to the manufacture of washers, rings, links for chains, and other like articles from sheet-metal. The patent of G. F. Champorez of Berlin, Prussia, relates to improvements in the manufacture of steel or iron and steel dies, and to certain contrivances for producing the same, the said dies being in depression or relief, without recourse to the hitherto universally employed engraving tool. Cole's patent (10th February 1875) relates to a composition for dress-fastenings generally, consisting of black composition of equal parts by weight of gas tar or tar varnish, whiting or chalk or clay, and lamp black or vegetable black. For a coloured composition transparent varnish, or the waste refuse of it, is substituted for gas tar or tar varnish, and a powdered pigment of the required colour is added. The materials should be thoroughly mixed and converted into a plastic, pasty mass, which is consolidated and hardened by rolling and drying. To give

toughness short pieces of fibrous material may be introduced. The articles are shaped from the composition by stamping in stamps or presses, and then varnished and polished.

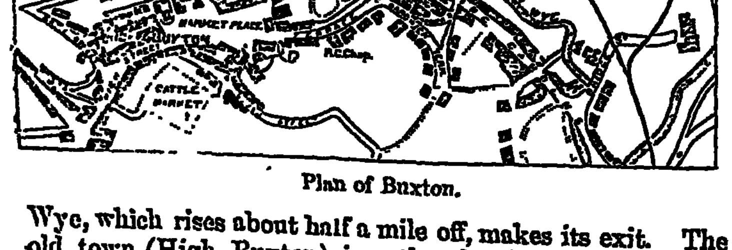
Messrs Green, Cadbury, & Richards, Birmingham, manufacture a linen button called "The very Button" (Shakespeare), in addition to others of innumerable kinds, and studs for shirts, collars, and wristbands, not only of plain materials but of gold and silver and jewelled. They employ about 400 hands, and turn out weekly from 10,000 to 15,000 gross (12 dozen to the gross) of their linen buttons. The proprietors of this establishment take great interest in the welfare of their workpeople, and few of the adults have been in their employment less than from eight to eighteen years. There is a sick club in connection with the works, and a library containing at present about 1000 volumes. Fines are inflicted for certain irregularities; these, however, are not appropriated by the firm, but are expended, half in the purchase of books, and half as a contribution to the sick club.

The following is a comparative statement of the number of button manufactories at the localities where these articles are principally made, taken from the *Directories* of 1875:—

London, 58; Birmingham, 161; Paris, 140; Berlin, 49; Hamburg, 5; Darmstadt, 3; Offenbach on the Maine, 3; Lubeck, 2; Barmen (Prussia), 27; Elberfeld, 9; Breslau, 2; Lüdenschied (Westphalia), 14; Stuttgart, 6; Vienna—metal, 15; porcelain, 5; shirt, 6; silk, 11; Brussels, 5; New York city, 19; Brooklyn (N.Y.), 3; Philadelphia, 13; Waterbury (Conn.), 8; Boston (Mass.), 3, Attleborough (Mass.), 3; Springfield (Mass.), 2; Newark (N. Jersey), 4.

Abstracts of Specifications of Patents (Patent office); Ure's *Dictionary of Arts and Manufactures; Resources, Products, &c., of Birmingham and Midland Hardware District;* Strutt's *Habits of the English;* Newton's *London Journal; Birmingham Directories*, 1777, &c.; Hutton's *History of Birmingham; Great Industries of the United States.* (J. J. L.)

BUXTON, a market-town and fashionable watering-place of England, in the county of Derby, 31 miles N.W. of Derby, and 160 from London, connected with Derby by the Buxton and Rowsley extension line, and with Manchester by the Stockport, Disley, and Buxton Railway. It occupies a high position, being 900 feet above the sea-level, in an open hollow, surrounded at a distance by hills of considerable elevation, except on the S. E. side, where the



Plan of Buxton.

Wye, which rises about half a mile off, makes its exit. The old town (High Buxton) is rather higher than the new, and consists of one wide street, and a considerable market place with an old cross. With the exception of some good inns and lodging-houses, the buildings in this part are commonplace. The new town is of a more elegant character, and has been greatly extended within the last twenty or thirty years. The crescent is a fine range of buildings in the Doric style, erected by the duke of Devonshire in 1779–86, at a cost of £120,000. It contains hotels, a ball-room, a bank, a library, and other establishments, and the surrounding open grounds have been laid out in terraces and gardens under the control of the Buxton Improvements Company. The Old Hall Hotel at the west end of the crescent is remarkable as the site of the mansion built by the earl of Shrewsbury in the reign of Queen Elizabeth, which was the residence of Queen Mary of Scotland when she visited the town. The new church was erected in 1812 by the duke of Devonshire; the edifice which it superseded has since been restored. The mineral waters of Buxton, the most noted in England, are particularly efficacious in cases of rheumatism and gout. There are numerous public and private baths, the most important of which are those in the new and spacious establishment at the eastern end of the crescent. The springs supply hot and cold water at a very short distance of each other, flowing at the rate of 60 gallons a minute. The former possesses a uniform temperature of 82° Fahr., and the principal substances in solution are, according to the analysis of Dr Muspratt in 1860—carbonate of lime, carbonate of magnesia, chloride of sodium, chloride of calcium, and silica. There is also a chalybeate spring known as St Anne's well, situated at the S.W. corner of the crescent, the water of which when mixed with that of the other springs proves purgative. The Devonshire Hospital, formerly known as the Bath Charity, is a benevolent institution, supported entirely by voluntary subscriptions, for the reception and free treatment of poor patients from any part of the country. About 900 or 1000 persons are annually indebted to its founders. The Buxton season extends from June to October, and during that period the town is visited by thousands annually. The public walks are tastefully laid out. The Cavendish Terrace, 500 yards long, forms a fine promenade; there are excellent drives in the park, which occupies more than 100 acres, and the neighbourhood of the town is rich in objects of interest. Of these the chief are—Poole's Hole, a vast stalactite cave, about half a mile distant, now lighted with gas for the convenience of visitors; Diamond Hill, which owes its name to the quartz crystals which are not unfrequent in its rocks; and Chee Tor, a remarkable cliff, on the banks of the Wye, 300 feet high. Ornaments are manufactured by the inhabitants from alabaster and spar; and excellent lime is burned at the quarries near Poole's Hole. Other places of interest, but more distant, are the caverns and mires of Castleton, Haddon Hall, and Chatsworth, the seat of the duke of Devonshire. The population in 1871 within the jurisdiction of the Local Board of Health was 3717; but the fluctuating population during summer varies from 4000 to 5000 at a time.

To judge from the remains of baths and other structures which have at various times been discovered, and the fact that they are situated near the crossing of two military roads, it seems almost certain that the mineral springs of Buxton were known to the Romans; but by what name they were then designated has not been ascertained. We find them a favourite resort in the period before the Reformation, when the patients were in the habit of offering their crutches or articles of attire to the image of St Anne, the tutelar saint, in token of their gratitude for benefit derived from the springs. Sir William Basset, at the command of Henry VIII., destroyed the "tabernacle" and prohibited the practice; but the wells seem to have lost none of their reputation by the loss of their saint, and continued to be a favourite resort in the last part of the century. Their praises were sounded in 1572 by John Jones, "Phisition at the King's Mede, near Darby," in *The Benefits of the Ancient Baths of Buckstones*, and at a later period they were celebrated by Hobbes and Cotton in their respective accounts of the wonders of the Peak. See also Thomas Brown's *Tour in Derbyshire*, and among modern works, Sir Charles Scudamore's *Tepid Springs of Buxton*, 1839; Robertson's *Mineral Waters*, 1854; L. Jewitt's *History of Buxton*.

BUXTON, Jedediah, a prodigy of skill in numbers, was born in 1704, at Elmton, near Chesterfield in Derbyshire. Although his father was schoolmaster of the parish, and his grandfather had been the vicar, his education had been so neglected that he could not write; and his knowledge, except of numbers, was extremely limited. How he came first to know the relative proportions of numbers, and their progressive denominations, he did not remember; but on such matters his attention was so constantly rivetted, that he frequently took no cognizance of external objects, and when he did, it was only with reference to their numbers. He worked out every question after his own method, without any external aid, and without understanding the common rules of arithmetic. He would stride over a piece of land or a field, and tell the contents of it almost as exactly as if it had been measured by the chain. In this manner he measured the whole lordship of Elmton, consisting of some thousand acres, and gave the contents not only in acres, roods, and perches, but even in square inches. After this, for his own amusement, he reduced them into square hairs'-breadths, reckoning forty-eight to each side of the inch. His memory was so great, that in resolving a question he could leave off and resume the operation again at the same point after the lapse of a week, or even of several months. His perpetual application to figures prevented the smallest acquisition of any other knowledge. On his return from church it never appeared that he had brought away one sentence, his mind having been busied in his favourite occupation. His wonderful faculty was tested in 1754 by the Royal Society of London, who acknowledged their satisfaction by presenting him with a handsome gratuity. During his visit to the metropolis he was taken to see the tragedy of Richard III. performed at Drury Lane theatre, but his whole mind was given to the counting of the words uttered by Garrick. Similarly, he set himself to count the steps of the dancers; and he declared that the innumerable sounds produced by the musical instruments had perplexed him beyond measure. He lived till about the age of seventy, and died at the place of his birth.

BUXTON, Sir Thomas Fowell (1786–1845), a distinguished philanthropist, whose name is inseparably associated with that of Wilberforce in the abolition of slavery, was born in Essex, April 1, 1786. He was not educated at any of the public schools, and at about the age of eighteen he entered Trinity College, Dublin, with a very slender stock of acquirements. But he was aware of his defects, and laboured so earnestly that he came out one of the first men of his time, and with an extraordinarily high reputation as a speaker. In 1809 he married Harriet Gurney, sister of the celebrated Mrs Fry. As his own means were not of themselves sufficient to support his family, he entered in 1808 the brewery establishment of Truman, Hanbury, and Co., of which his uncles, the Hanburys, were partners. He devoted himself to business with characteristic enthusiasm, became a partner in 1811, and soon had the whole concern in his hands. In 1816 he brought himself into notice by his speech in behalf of the Spitalfields weavers, and in 1818 he published his able *Inquiry into Prison Discipline*. The same year he was elected member for Weymouth, a borough for which he continued to sit till 1837. In the House of Commons he had a high reputation as an able and straightforward speaker, devoted to philanthropic schemes. Of these plans the most important was that for the abolition of slavery in the British colonies. Buxton devoted his life to this object, and through defeat and opposition, despite the attacks of enemies and the remonstrances of faint-hearted friends, he remained true to it. Not till 1833 was he successful, and even then only partially, for he was compelled to admit some clauses against which his better judgment had decided. In 1837 he ceased to sit in the House of Commons. He travelled on the Continent in 1839 to recruit his health, which had given way, and took the opportunity of inspecting Continental prisons. He was made a baronet in 1840, and then devoted himself to a plan for ameliorating the condition of the African negroes. The failure of the Niger expedition was a blow from which he never recovered. He died on the 19th February 1845. (See *Memoir and Correspondence of Sir T. F. Buxton*, edited by his son, Charles Buxton, 1848.)

BUXTORF, or Buxtorff, John (1564–1629), the first of a line of distinguished scholars, whose Hebrew and rabbinical learning shed lustre upon the university of Basel during the 17th century, was born at Camen in Westphalia on the 25th December 1564. The original form of the name was Bockstrop, or Boxtrop, from which was derived the family crest or insignia, which bore the figure of a goat (*Bock* in German signifying "he-goat"). His early education was received at the schools of Hamm and Dortmund. After the death of his father, who was minister of Camen, Buxtorf resumed his studies, which had been interrupted for a short time by that event, at Marburg, and the newly-founded university of Herborn, at the latter of which Olevian and Piscator had been recently appointed professors of theology. It was under the teaching of Piscator that Buxtorf first imbibed a love for the Hebrew language and literature, that department in which he was destined afterwards to become so famous. So great was his progress in these studies, that Piscator acknowledged that he was far surpassed by his pupil. At a later date Piscator received the assistance of Buxtorf in the preparation of his Latin translation of the Old Testament, which was published at Herborn in 1602–3. From Herborn Buxtorf repaired to Heidelberg, and thence to Basel, to which latter university he was attracted by the reputation of John James Grynæus and Hospinian. After a residence of some time at Basel, Buxtorf proceeded to Zurich, for the purpose of attending the lectures of Bullinger, and after that to Geneva, where he enjoyed for a short time the instructions of Beza. On his return to Basel, Grynæus, who had been greatly impressed by the character, talents, industry, and great learning of the youth, and was desirous that the services of one who promised to become a scholar of great distinction should be secured to the university, procured him a situation as tutor in the family of Leo Curio, son of Cœlius Secundus Curio, so celebrated for his sufferings on account of the Reformed faith. This arrangement exercised a decisive influence upon the future life, public and private, of Buxtorf. At the instance of Grynæus, Buxtorf undertook the duties of the Hebrew chair in the university, and discharged them for two years with such ability and acceptance, that at the end of that time he was unanimously appointed to the vacant office. From this date (1590) to his death in 1629, a period of thirty-nine years, Buxtorf remained in Basel, and devoted himself to the study of Hebrew and rabbinical literature with an energy and zeal that have rarely been paralleled in the history of any scholar. He is said never to have devoted fewer than eight or ten hours daily to study. Not satisfied with perusing the works of the rabbins, he received into his own house many learned Jews, that he might discuss with them the more difficult and abstruse points treated of in the writings of their countrymen. So great, indeed, became his reputation for profound and extensive knowledge of rabbinical books, that he was frequently consulted by Jews themselves on matters relating to their ceremonial law. Probably no Protestant scholar ever possessed so complete a knowledge of the contents of the rabbinical writings as Buxtorf, and he

seems to have well deserved the title which was conferred upon him of "Master of the Rabbins." His partiality for Jewish society exposed him, indeed, on one occasion to considerable annoyance. He had received a Jew named Abraham into his house in order to assist him in the editing of his great Rabbinical Bible. Abraham's wife was confined of a boy, whose circumcision, agreeably to Hebrew usage, had to take place on the eighth day after birth, and it was necessary that at least two Jewish witnesses should be present at the ceremony. Buxtorf obtained permission from the chief officer of the town council to allow two Jews from a distance to assist on the occasion, while he himself, his son-in-law, and two citizens of Basel, were also present. This proceeding, however, gave great offence to the authorities of the city, the laws against the Jews being at this time exceedingly stringent. The result was that Buxtorf and his son-in-law were each fined 100 florins, the father of the boy 400 florins, while the officer of the municipality and the two citizens were punished with three days' imprisonment. Notwithstanding this occurrence, however, Buxtorf's relations with the city of Basel were of a friendly kind. He remained firmly attached to the university which first recognized his merits, and declined two invitations which were offered him, from Leyden and Saumur successively, to fill the Hebrew chair in these famous schools. His correspondence with the most distinguished scholars of the day was very extensive, and in the rich collection of letters preserved in the library of the university of Basel, are contained materials for a literary history of the time which it is hoped may be one day utilized.

The works which Buxtorf published during his life are too numerous to be all enumerated in this brief notice, and for a complete list of them the reader is referred to the authorities cited at the close of the article. The following, however, may be mentioned. In 1602 appeared his *Manuale Hebraicum et Chaldaicum*, which reached a seventh edition in the year 1658. In the following year was published his *Synagoga Judaica*, which appeared first in German and was afterwards translated into Latin in an enlarged form, and which constitutes a valuable repertory of information regarding the opinions and ceremonies of the Jews. In 1607 he published his *Lexicon Hebraicum et Chaldaicum cum brevi Lexico Rabbinico Philosophico*, which was reprinted at Glasgow so recently as 1824. In 1618 there appeared in two folio volumes his great *Rabbinical Bible*, containing, in addition to the Hebrew text, the Chaldee Paraphrases or Targums, which he punctuated after the analogy of the Chaldee passages in Ezra and Daniel (a proceeding which has been condemned by Richard Simon and others), and the Commentaries of the more celebrated Rabbins, with various other treatises. Of this work it may be said that Rosenmuller's judgment will approve itself to most Hebrew scholars,—that "this edition is indispensable to every one who desires thoroughly to study the criticism and exposition of the Old Testament."—(Rosenmuller, *Handbuch für die Literatur der Biblischen Kritik und Exegese*, vol. i. p. 259). The Bible was followed by his *Tiberias, sive Commentarius Masoreticus*, so named from the great school of Jewish criticism which had its seat in the town of Tiberias. It was in this work that Buxtorf controverted the views of Elias Levita regarding the late origin of the Hebrew vowel points, a subject which gave rise to the famous controversy between Cappellus and his son John Buxtorf, which will be referred to in the following article. Buxtorf did not live to complete the two works on which his reputation chiefly rests, viz., his great *Lexicon Chaldaicum, Talmudicum, et Rabbinicum*, and the *Concordantiæ Bibliorum Hebraicorum*, both of which were edited by his son. They are monuments of untiring labour and industry, and possess an enduring value. The former work has been recently (1869) republished at Leipsic with some additions by Bernard Fischer, Ph.D., and the latter was assumed by Fürst as the basis of his great Hebrew concordance, which appeared in 1840. For additional information regarding his writings the reader is referred to *Athenæ Rauricæ*, pp. 444–448; to the article "Buxtorf" in Ersch and Gruber's *Encyclopædia*; to the *Theological Cyclopædias* of Herzog, and of Wetzer and De Welte, *sub voce* "Buxtorf"; to Niceron's *Memoires*, vol. xxxi. pp. 206–215; to Schrokh's *Kirchengeschichte*, vol. v. (Post-Reformation period) pp. 72 *sq.*, Leipsic, 1806; and to Meyer's *Geschichte der Schrift-Erklarung*, vol. iii., Göttingen, 1804. (F. C.)

BUXTORF, or BUXTORFF, JOHN (1599–1664), commonly called "junior," to distinguish him from his father, the subject of the preceding notice. He was born at Basel on the 13th August 1599, and at a very early age displayed remarkable aptitude for the acquisition of languages. When only four years old he was sent to school, at which age he is said to have been able to read Latin, Greek, and Hebrew, in which he had been instructed by his father. At the age of twelve he entered the university, where he speedily distinguished himself above not only his equals, but his seniors in years, to so great a degree that when only sixteen he received the diploma of master of arts from the hands of his own father. From this time he devoted himself to the study of theology, turning his attention especially to the Hebrew language and its cognate dialects, and then proceeding to the study of rabbinical Hebrew, in which he soon attained such proficiency, that he is said, while still a young man, to have read through not only the Mishna, but also the Jerusalem and Babylonian Gemaras, or commentaries upon the text of the Talmud. In conformity with the excellent custom, so long prevalent on the Continent, of visiting several universities before finally settling down to life-long professional work, Buxtorf proceeded to Heidelberg in 1617, where he listened to the prelections of the theologians Pareus, Scultetus, and the elder Alting. In 1619 he repaired to Dort, while the famous Synod was still sitting, and there made the acquaintance of many of the divines who took part in its proceedings. At the close of the Synod he made a short journey in company with the deputies from Basel, through the Netherlands and England, and thence through France back to Basel. On his return he found that his father's great Rabbinical Bible was in course of publication, and as there was no lexicon suitable for the study of the Chaldee Targums, comprised in the work, he undertook the compilation of such a lexicon, which appeared at Basel in 1622 under the title of *Lexicon Chaldaicum et Syriacum*, with a recommendatory preface from his father, detailing the circumstances under which the work had been executed. Still thirsting for knowledge, he repaired in 1623 to Geneva, to enjoy the instructions of the elder Turretin, Diodati, and Tronchin; while in return Turretin and Dav. Clericus did not disdain to avail themselves as pupils of his pre-eminent knowledge of Hebrew and of the rabbinical dialect. So great by this time had become his reputation as a scholar, that he was offered by the authorities of the city of Bern the chair of logic at Lausanne, which he declined, preferring to return to Basel, where in 1624, he was appointed general deacon to the church of Basel (*Communis Ecclesiæ Basileensis Diaconus*), and three years later deacon of St Peter's church. On the death of his father in 1629, Buxtorf was unanimously designated as the fittest person to succeed so distinguished a Hebraist; and by the advice of his physicians, who were of opinion that the labours involved in the discharge of the duties of a public preacher would be injurious to one whose constitution was feeble, he finally accepted the office. From this date until his death he remained at Basel, declining two offers which were made to him from Groningen and Leyden, to accept the Hebrew chair in these two celebrated schools. To mark their appreciation of his patriotic conduct, the governing body of the university founded in 1647, specially for his behoof, a third theological professorship, that of "Commonplaces and Controversies," the duties of which Buxtorf discharged for seven years along with those of the Hebrew chair. When, however, the professorship of the Old Testament became vacant in 1654 by the death of Theodore Zuinger, Buxtorf resigned the chair of theology, and accepted that of the Old Testament instead, holding both offices, and for some time that also of chief librarian to the university, until his death in 1664. The course of his private life was chequered by many domestic bereavements. He was four times married,

his three first wives dying shortly after marriage, and the fourth predeceasing her husband by seven years. His children also all died young, with the exception of two boys, the younger of whom, John James, became first his father's colleague, and shortly after his successor in the chair of Hebrew.

A considerable portion of his public life was spent in controversy regarding disputed points in Biblical criticism, in reference to which he had to defend the views advanced by his father. The attitude of the Reformed churches at that time, as opposed to the Church of Rome, led them to take up and maintain many opinions in regard to Biblical questions, which were not only erroneous in point of fact, but which were altogether unnecessary for the stability of their position. Having renounced the dogma of an infallible church, it was deemed necessary to maintain as a counterpoise, not only that of an infallible Bible, but, as the necessary foundation of this, of a Bible which had been handed down from the earliest ages to the present time without the slightest alteration or change in its text. The letters in which the Old Testament was written, were, it was asserted, the same as those in which the two tables of the law had been written; the vowel points and accents which accompanied them had been given by divine inspiration; and the words themselves had not undergone the slightest change from the time they had flowed from the pens of the respective writers. The Masoretic text of the Old Testament, therefore, as compared either with that of the recently discovered Samaritan Pentateuch, or of the Septuagint, or of the Vulgate, was alone the "Hebrew Verity," wherein the true words of the sacred writers were to be found. Although many of the Reformers, as well as learned Jews, had long seen that these assertions could not be made good, there had been as yet no formal controversy upon the subject. It was reserved for a learned and acute Frenchman, Ludovicus Cappellus the younger, professor of Hebrew at Saumur, to enter the field, and by a series of controversial writings effectually to dispel the illusions which had long prevailed in many minds. As early as 1622 or 1623, Cappellus had submitted in manuscript to the elder Buxtorf a work on the modern origin of the vowel points and accents, which he had been led to undertake in consequence of the statements made by the Swiss professor in his *Tiberias*, or *Commentary on the Masora*, in which he had controverted the views of Elias Levita on the *late* origin of the points. Buxtorf saw the force of the arguments employed by Cappellus, but counselled him not to publish his work, pointing out the injury which it would do to the Protestant cause, and the advantage which it would afford to Romish controversialists on the question of the infallible accuracy of the text of Scripture. Cappellus, however, was not to be deterred by fear of consequences. He sent his MS. to Thomas Erpenius of Leyden, the most learned Orientalist of his day, by whom it was published in 1624, under the title *Arcanum Punctationis revelatum*, with a laudatory preface, but without the author's name. In this work Cappellus adduced those arguments and considerations which have satisfied most scholars since his day that the vowels and accents are the invention of the Masoretes, and that they are not older than the fifth century of the Christian era. It is worth noting that although the elder Buxtorf lived five years after the publication of the work, he made no public reply to it, and it was not until 1648, nearly a quarter of a century afterwards, that Buxtorf, junior, published his *Tractatus de punctorum origine, antiquitate, et authoritate, oppositus Arcano punctationis revelato Ludovici Cappelli*. In this treatise he endeavoured to prove by copious citations from the rabbinical writers, and by arguments of various kinds, that the points, if not so ancient as the time of Moses, were at least as old as that of Ezra, and thus possessed the authority of divine inspiration. In the course of the work he allowed himself frequently to employ contemptuous epithets towards Cappellus, such as "innovator," "prophet," "revealer," "a seer of visions," "dreams," &c. Cappellus was not the man to remain silent in such circumstances. He speedily prepared a second edition of his work, in which, besides replying to the arguments of his opponent, and fortifying his position with new ones, he retorted his contumelious epithets with interest. Owing to various causes, however, among which may be mentioned the distrust with which Cappellus was coming to be regarded on account of his critical opinions among Protestants themselves, this second edition did not see the light until thirty years after his death, when it was published at Amsterdam in 1685, in the edition of his collected works. Besides this controversy, Buxtorf engaged in three others with the same antagonist, on the subject of the integrity of the Masoretic text of the Old Testament, on the antiquity of the present Hebrew characters, and on the Lord's Supper. Into the details of these, however, our space does not allow us to enter. In the two former Buxtorf supported the untenable position that the text of the Old Testament had been transmitted to us without any errors or alteration, and that the present square or so-called Chaldee characters were coeval with the original composition of the various books. These views were triumphantly refuted by his great opponent in his *Critica Sacra*, and in his *Diatriba de veris et antiquis Ebraicorum literis*. Besides the works which have been already mentioned in the course of this article, Buxtorf edited the great *Lexicon Chaldaicum, Talmudicum, et Rabbinicum*, on which his father had spent the labour of twenty years, and to the completion of which he himself gave ten years of additional study, and the great Hebrew *Concordance*, which his father had little more than begun. In addition to these, he published new editions of many of his father's works, as well as others of his own, complete lists of which may be seen in the *Athenæ Rauricæ*, and other works enumerated at the close of the preceding article. (F. C.)

BUZZARD, a word derived from the Latin *Buteo*, through the French *Busard*, and used in a general sense for a large group of Diurnal Birds-of-prey, which contains, among many others, the species usually known as the Common Buzzard (*Buteo vulgaris*, Leach), though the English epithet is now-a-days hardly applicable. The name Buzzard, however, belongs quite as rightfully to the birds called in books "Harriers," which form a distinct subfamily of *Falconidæ* under the title *Circinæ*, and by it one species, the Moor-Buzzard (*Circus æruginosus*), is still known in such places as it inhabits. "Puttock" is also another name used in some parts of the country, but perhaps is rather a synonym of the Kite (*Milvus ictinus*). Though ornithological writers are almost unanimous in distinguishing the Buzzards as a group from the Eagles, the grounds usually assigned for their separation are but slight, and the diagnostic character that can be best trusted is probably that in the former the bill is decurved from the base, while in the latter it is for about a third of its length straight. The head, too, in the Buzzards is short and round, while in the Eagles it is elongated. In a general way Buzzards are smaller than Eagles, though there are several exceptions to this statement, and have their plumage more mottled. Furthermore, most if not all of the Buzzards, about which anything of the kind is with certainty known, assume their adult dress at the first moult, while the Eagles take a longer time to reach maturity. The Buzzards are fine-looking birds, but are slow and heavy of flight, so that in the old days of falconry they were regarded with infinite scorn, and hence in common English to call a man "a buzzard" is to denounce him as stupid. Their food consists of small mammals, young birds, reptiles, amphibians, and insects,—particularly beetles,—and thus they never could have been very injurious to the game-preserver, though they have fallen under his ban, if indeed they were not really his friends, but at the present day they are so scarce that in this country their effect, whatever it may be, is inappreciable. Buzzards are found over the whole world with the exception of the Australian region, and have been split into many genera by systematists. In the British Islands we have two species, one resident (the *B. vulgaris* already mentioned), and now almost confined to a few wooded districts; the other the Rough-legged Buzzard (*Archibuteo lagopus*), an irregular winter-visitant, sometimes arriving in large bands from the north of Europe, and readily distinguishable from the former by being feathered down to the toes. The Honey-Buzzard (*Pernis apivorus*), a summer-visitor from the south, and breeding, or attempting to breed, yearly in the New Forest, does not come into the subfamily *Buteoninæ*, but is probably the type of a distinct group, *Perninæ*, of which there are other examples in Africa and Asia. (A. N.)

BYNG, GEORGE (1663–1733), Viscount Torrington, a distinguished English admiral, was born at Wrotham, Kent, and at the age of fifteen went to sea as a volunteer. After being several times advanced, he was in 1702 raised to the command of the "Nassau," a third rate, and was at the taking and burning of the French fleet at Vigo; and the next year he was made rear-admiral of the red. In 1704 he served in the grand fleet sent to the Mediterranean, under Sir Cloudesley Shovel, as rear-admiral

of the red, and reduced Gibraltar. He was in the battle of Malaga, which followed soon afterwards, and for his gallantry in that action received the honour of kinghthood. In 1718 he was made admiral and commander-in-chief of the fleet, and was sent with a squadron into the Mediterranean for the protection of Italy. This commission he executed so well that the king made him a handsome present, and sent him full powers to negotiate with the princes and states of Italy, as there should be occasion. He procured the emperor's troops free access into the fortresses which still held out in Sicily, sailed afterwards to Malta, and brought out the Sicilian galleys, and a ship belonging to the Turkey Company. By his advice and assistance the Germans retook the city of Messina in 1719, and destroyed the ships which lay in the basin—an achievement which completed the ruin of the naval power of Spain. The Spaniards being much distressed offered to quit Sicily; but the admiral declared that the troops should never be suffered to depart from the island till the king of Spain had acceded to the quadruple alliance, and to his conduct it was entirely owing that Sicily was subdued, and the king forced to accept the terms prescribed him by the alliance. On his return to England he was made rear-admiral of Great Britain, a member of the privy council, Baron Byng of Southill, in the county of Bedford, and Viscount Torrington in Devonshire. He was also made one of the Knights Companions of the Bath upon the revival of that order in 1725. In 1727 George II., on his accession to the crown, placed him at the head of naval affairs as first lord of the Admiralty. He died January 15, 1733, in the seventieth year of his age, and was buried at Southill, in Bedfordshire.

BYNG, The Hon. John (1704–1757), British admiral, fourth son of the subject of the preceding notice, entered the navy at an early age, became captain in 1727, and in 1745 was made rear-admiral of the red. In the year 1755 the British Government received intimation that the French were fitting out a naval expedition in Toulon, and it behoved them to attend to the defences of Gibraltar and Minorca. Nothing, however, was done until the intentions of the French were too apparent, and Byng was then entrusted with ten miserably equipped ships of war, and set sail from Spithead on the 7th April 1756. He put in at Gibraltar to receive stores, and there learnt that the French had made good their descent upon Minorca. On the 19th May he came in sight of St Philip's, still held by the British, but failed to establish communications with the governor. On the following day he engaged with the French fleet, which was inferior in number of vessels, but vastly superior in armament and equipment. There seems no doubt that the division under Byng's charge did not second with sufficient eagerness the bold attack made by Admiral West. The action was indecisive, and next morning Byng called a military council, and it was resolved that, under the circumstances, it was hopeless to attempt anything further, and that Minorca must be left to its fate. The fleet returned to Gibraltar. The indignation of the English at the transaction was intense, and the Government took advantage of it to avert from themselves the charge of incapacity. Byng was at once superseded and brought home under arrest. A court-martial on his conduct sat during December 1756 and January 1757, and found that the admiral had not done his utmost to relieve St Philip's, or to defeat the French fleet, though they fully acquitted him of cowardice or treachery. The only punishment open to them to inflict was that of death, and they passed their sentence with the utmost reluctance, coupling it with an earnest recommendation to mercy. No attention was paid to this or to other attempts to mitigate what was felt to be an unduly severe punishment for mere incapacity. The unfortunate admiral was shot on the 14th March 1757.

BYNKERSHOEK, Cornelius Van (1673–1743), a distinguished Dutch jurist, was born at Middleburg in Zeeland. In the prosecution of his legal studies, and while holding the offices first of member and afterwards of president of the supreme court, he found the common law of his country so defective as to be nearly useless for practical purposes. This abuse he resolved to reform, and took as the basis of a new system the principles of the ancient Roman law. His works are very voluminous. The most important of them are the *Observationes Juris Romani*, published in 1710, of which a continuation in four books appeared in 1733; the treatise, *De Dominio Maris*, published in 1721; and the *Quæstiones Juris Publici*, published in 1737. Complete editions of his works were published after his death; one in folio at Geneva in 1761, and another in two volumes folio at Leyden in 1766.

BYROM, John (1691–1763), a poet and miscellaneous writer, was born at Kersall, near Manchester, and educated at Trinity College, Cambridge. His first poetical essay, the well-known *Colin and Phœbe*, appeared in the *Spectator*, No. 603. After leaving the university he studied medicine at Montpellier, and became a convert to the mystical theology of Bourignon and Boehme. He was elected a member of the Royal Society in 1723. Having reduced himself to narrow circumstances by a precipitate marriage, he supported himself by teaching a new method of shorthand writing, of his own invention, till he succeeded to an estate on the death of an elder brother. He was a man of lively wit, of which, as opportunity offered, he gave many specimens. A collection of his miscellaneous poems was printed at Manchester, in two vols. 8vo, 1773, and reprinted at Leeds in 1814, with a life of Byrom by an anonymous writer. Byrom's *Private Journal and Correspondence* have appeared among the publications of the Chetham Society (vols. xxxiv. and xliv.)

BYRON, George Gordon Noel Byron, Lord (1788–1824). The portrait of the most remarkable figure in the literature of this century is still too often made up on the principle of putting in all the shadows and leaving out all the lights. Not only the facts of his own life, but even the records and traditions of his ancestry, are partially selected in this way. It is true, no doubt, that a man's immediate ancestors must be supposed to have most influence on his character, and that Byron's immediate ancestors were far from being quiet, respectable people. His father, Captain Byron, was a profligate officer, whose first wife was a divorced lady with whom he had eloped to France, who married a second time only to find the means for paying his debts, and who left his wife as soon as her fortune was exhausted. His mother, Catherine Gordon, heiress of Gight in Aberdeenshire, was a fitful and passionate woman, who knew no stable halting-place between the extremes of indulgent fondness and vindictive disfavour. His grand-uncle, whom he succeeded in the title, had killed his neighbour and relative, Mr Chaworth, in a drunken brawl, had been tried before the House of Lords on the charge of murder and acquitted, but had been so wrought upon by remorse and the sense of public opprobrium, that he shut himself up at Newstead, let the place go to ruin, and acquired such a bad repute by his solitary excesses that he was known as the "wicked Lord Byron." Even in this wild ancestry it is easy to detect the corruption of good things. In other parts of the family line the nobler elements are seen running clear and pure. The poet's grandfather, Admiral Byron, "Foul-weather Jack," who had as little rest on sea as the poet on land, had the virtues without the vices of the race. Farther down the family tree we find the Byrons distinguishing themselves in the field. Seven brothers fought in the

battle of Edgehill. None of the family would seem to have been stirred by the poetic impulse in the brightest period of English song, but later on, under Charles II., there was a Lord Byron who patronized literature, and himself wrote some verses in which he professed—

> "My whole ambition only doth extend
> To gain the name of Stedman's faithful friend."

Sir Egerton Brydges, however, has found a poetic ancestry for Byron by connecting the Byrons of the 17th century with the family of Sydney.

The poverty into which Byron was born, and from which his accession to high rank did not free him, had much to do in determining his future career. That he would have written verses in whatever circumstances he had been born we may safely believe; but if he had been born in affluence we may be certain that, with his impressionable disposition, he would never have been the poet of the Revolution—the most powerful exponent of the modern spirit. By the time of his birth (at Holles Street, London, January 22, 1788), his father had "squandered the lands o' Gight awa," and his mother was on her way back from the Continent with a small remnant of her wrecked fortune. Mrs Byron took up her residence in Aberdeen; and her "lame brat," as she called him in her fits, was sent for a year to a private school at 5s. a quarter, and afterwards to the grammar school of the town. Many little stories are told of the boy's affectionate gratitude and venturesome chivalry, as well as of his exacting and passionate temper. The sisters Gray, who were his successive nurses, found him tractable enough under kind treatment. His mother, whose notions of discipline consisted in hurling things at him when he was disobedient, had no authority over him; he met her violence sometimes with sullen resistance, sometimes with defiant mockery; and once, he tells us, they had to wrench from him a knife which he was raising to his breast. At school he passed from the first to the fourth class, but with all his ambition to excel he was too self-willed to take kindly to prescribed tasks, too emotional for dry intellectual work; and he probably learned more from Mary Gray, who taught him the Psalms and the Bible, than he did from his schoolmaster. Before he left Aberdeen, which he did on the death of his grand-uncle and his accession to the peerage in May 1798, he gave a remarkable proof of the precocious intensity of his affections by falling in love with his cousin Mary Duff. So strong a hold did this passion take of him, that six years afterwards he nearly went into convulsions on hearing of her marriage.

When Byron's name was first called in school with the prefix "Dominus," the tradition is that he burst into tears,—from pride, M. Taine conjectures,—from pain at the gulf thus placed between him and his school-fellows, the Countess Guiccioli. Soon after, his mother, who had frequently taken advice for the cure of his lame foot, went with him to Nottingham, and placed him under the care of an empiric, who tortured him to no purpose. The torture was renewed under the advice of a London physician at Dr Glennie's school at Dulwich, at which he was entered in the summer of 1799; and at last the foot, as he wrote to his old Scotch nurse, was so far restored that he was able to put on a common boot. He was two years with Dr Glennie, and though he made little progress in his classical studies, he had the run of his master's library, and added greatly to his general information. Before he left for Harrow he had contracted another passion for his cousin Margaret Parker, so intense that he could not sleep nor eat when he was looking forward to meeting her. He went to Harrow in 1801, "a wild northern colt," as the head-master said of him, very much behind his age in Latin and Greek. This deficiency he never quite overcame, though he worked enough to get into the same form with boys of his own age. Antiquarian studies never had any charm for him. But though, according to his own account, he was always cricketing, rebelling, and getting into mischief, his brain was not idle. Partly to keep up his school repute for "general information," he read every history he could lay hands on, and not without system either, for he set himself deliberately to know something about every country. He also went through all the British classics, both in Johnson and in Anderson, and most of the living poets. Few boys left Harrow with such a store of useful learning. Many anecdotes are told of the warmth of his friendships at Harrow, and his chivalry in defending his juniors. In the vacation of 1803 he again fell in love—this time more seriously—with Miss Chaworth, whose grandfather "the wicked Lord Byron" had killed. In the melancholy moods of his after life her rejection of him was often a subject of passionate regret.

Byron's residence at Cambridge (Trinity College, 1805 to 1808, with interval of a year) added little to his knowledge of academical learning. The arts in which he qualified himself to graduate were swimming, riding, fencing, boxing, drinking, gaming, and the other occupations of idle undergraduates. When he went up to Cambridge he was wretched, he tells us, partly from leaving Harrow, partly "from some private domestic circumstances of different kinds," chiefly, it may be presumed, the want of money; but his friend Scrope Davies lent him large sums, and he lived with a certain reckless happiness which had a great deal more to do with his moodiness and melancholy than the libertine excesses with which he is popularly credited. Much more important than his residence in Cambridge, as bearing on his mental development, was his year's residence at Southwell. From that happy period, which saw the serious dawn of his genius, M. Taine has picked out only the unhappy violent quarrel with his mother, which was the cause of its termination. His intimacy with the Pigotts, and the expansion of his poetic impulses under their genial encouragement, are much more worthy of notice than this culmination of miserable bickerings which he was now strong enough to laugh at, when the domestic storm was over. He had scribbled many verses at Harrow, but had been too shy to show them to his roystering friends; and now finding for the first time an admiring audience, he put forth his powers in earnest, as he could do only under the influence of love or defiance. The result came before the public in the *Hours of Idleness*, published by Ridge of Newark in March 1807.[1] The poems in that collection have something of the insipidity of the circumstances that gave them birth, but the fact of publication bound him to his vocation to a degree of which he was not at all aware. Hitherto his ambition had pointed towards politics as his natural field, and he said as much in the somewhat disdainful preface to his poems. Putting his ambition into verse, he characteristically compared himself to a slumbering volcano, and longed to burst on the world as a Fox or a Chatham. But the *Hours of Idleness* decided his career for him. When he went back to Trinity College he could not help eagerly watching their effect. Again and again he wrote to the friendly Miss Pigott to hear how they were succeeding. He was prepared for defeat, he said, and he promised to take vengeance on adverse critics. He was made a new man by the publication; he had tasted public applause and hungered for more of it. It was then that he carefully examined himself, and took stock of his acquirements in the very remarkable document dated

[1] He had previously printed a volume for private circulation, and it is characteristic of his docility, under gentle influences, that he burnt the first impression when Mr Becher rebuked him for the too warm colouring of one of the poems.

November 30, 1807, to which we are indebted for our knowledge of the extent of his studies. In the midst of his rollicking set at Cambridge he was secretly girding up his loins, and collecting his powers to make a grand struggle for fame. Perhaps no poet was ever drawn out so directly by the thirst for public honour; no poet ever appealed so directly to the public eye and heart. He launched himself bodily before the world, almost ravenous for sympathy and homage.

It is generally said that but for the savage attack of the *Edinburgh Review* in the spring of 1808 Byron might never have returned to poetry. But the fact is that the review did not appear till a year after the publication of *Hours of Idleness*, and in the interval Byron, for all his farewell to poetry, was "scribbling," as he called it, more furiously than ever. "I have written," he wrote to Miss Pigott, six months before the Edinburgh attack, "214 pages of a novel; one poem of 380 lines, to be published (without my name) in a few weeks with notes; 560 lines of *Bosworth Field*, and 250 lines of another poem in rhyme, besides half a dozen smaller pieces. The poem to be published is a satire." This satire was the poem which he afterwards converted into a reply to the *Edinburgh Review*. He anticipated censure, and fore-armed himself—always as eager to defy reproof as he was to win applause. Apparently he put off publishing his satire till all his critics should have had their say, and he should know clearly where to hit. When the attack came it wounded him bitterly; but a friend who called on him at the time thought from the fierce light in his eye that he had received a challenge. He was in no hurry to publish; he worked at leisure, with a confident consciousness of his powers, and *English Bards and Scotch Reviewers* did not make its appearance till the spring of 1809. When it did appear the authorship was soon discovered, and it was the talk of the town. To us who look back upon it dispassionately, and compare its somewhat heavy and mechanical couplets with the exquisite lightness and fitting-point of its antitype the *Dunciad*, the satire appears to possess no great force; but the personalities told at the time, when there was a vague unrest in the literary world at the outspoken severity and sometimes truculent malice of the Scotch review, and the injured poet had his revenge in a general acknowledgment that the objects of his wrath deserved castigation, and that the lash was well laid on.

Soon after the publication of his satire, Byron, in June 1809, left for his travels on the Continent; and one would have expected that the young lord, with the wreath of triumph still fresh on his head after his first literary battle, would have gone on his journey with satisfaction and hopeful curiosity. He sailed in deep dejection, with all the bitterness of a man who feels himself friendless and solitary, and he returned after two years' wandering in Spain, Albania, Greece, Turkey, and Asia Minor, sadder than before. Why was this? Those who identify him with his own Childe Harold, are ready with the answer that he had lived a life of dissolute pleasure, and was already, at the age of twenty-one, experiencing the pains of satiety and exhaustion. But this is not borne out by such scanty light as he and his friends have thrown on his life at this period. He himself always protested, both in public and private, against being identified with Childe Harold. Childe Harold's manor was an old monastic residence; he left his country in bitter sadness; in the original MS. his name was Childe Burun; he left behind him a mother and a sister; and he passed through the scenes of Byron's travels. But there the resemblance ends. The resemblance is really confined, as the author alleged, to local details. There is no reason to disbelieve what the author affirmed, that Childe Harold was a purely fictitious character, "introduced for the sake of giving some connection to the piece." To make him what he intended—"a modern Timon, perhaps a poetical Zeluco,"—the poet drew, no doubt, upon his own gloomier moods; he felt occasionally as he makes Harold feel habitually, but the process was much more dramatic than the world, in spite of his protests, took for granted. Byron, with all his bitter moods of forlorn despondency, was too susceptible a spirit to "stalk in joyless reverie" through the south of Europe, as his letters home testify. And we know that his picture of the Bacchanalian feasts in the monastery, with "Paphian girls," and "flatterers and parasites," is not at all like what actually occurred at Newstead Abbey. There were no "laughing dames" there, except the domestics, and the flatterers and parasites were his bosom friends whom he loved with a romantic ardour. They held "high jinks" there as any young men might have done, masqueraded about in monkish habits to be in whimsical conformity with the place, practised pistol-shooting in the old hall, had a wolf and a bear chained at the entrance, had the garden dug up in search of concealed treasure, found a skull there, had it made into a cup, and passed this cup round after dinner, with the conceit that their mouths did it less harm than the worms, and that when its wit had ceased to sparkle, it had better be filled with Burgundy to make other wits sparkle than lie rotting in the earth. Byron himself was too poor, as Moore has remarked, to keep a harem, had such been his wish. He is known to have had a romantic passion for a girl who used to travel with him in England in boy's clothes; but whoever thinks he was satiated with this poor creature's devotion to him, should read the concluding stanzas of the second canto of *Childe Harold*, where the poet speaks in his own person, and laments her death in language utterly out of keeping with the dark unfeeling mood of his "modern Timon." One can then understand why he should have said that "he would not for worlds be a man like his hero." There is really very little of the personage Childe Harold in the poem; the poet simply has him by his side as a connecting link, while he describes the scenes through which he passed. In the two last cantos, indeed, Byron, angry that the public had identified him with Childe Harold, and then more defiant of public opinion, hardly cared to keep up the separation between his own character and the pilgrim's; and in the last canto he avowedly makes them coalesce.

To look for the causes of moodiness and melancholy in material circumstances is a very foolish quest; but we may be certain that insufficiency of this world's money, and the daily vexations and insults to which his rank was thereby exposed, had much more to do with Byron's youthful gloom than satiety of this world's pleasures. His embarrassed finances, and the impossibility of securing the respect due to his title, formed a constant source of annoyance, put his whole system into a morbid condition, in which every little slight and repulse festered and rankled with exaggerated virulence. From the daily humiliations and impertinences to which his false position exposed him, aggravated by his jealous and suspicious irritability, he may have turned sometimes to Childe Harold's consolations—"the harlot and the bowl," but his nature prompted him rather to forget his vexations in purer and worthier objects. Unfortunately for him, such impetuous and passionate affections as his could rarely find the response for which he craved. In those few cases where devotion was repaid with devotion, the warmth of his gratitude was unbounded; he loaded poor Thyrza's memory with caresses, careless of what the world might say, remembering only that the poor girl clung to him with unselfish love; and he returned his sister's tender regard with an ardour and constancy that showed how highly he prized and how eagerly he reciprocated

sincere affection. Circumstances that would have fallen lightly on a less sensitive man preyed upon his self-torturing spirit. In his dejection he had taken pleasure in the romantic notion of collecting the portraits of his friends, and one of them refused to sit on the ground that he could not afford it. Another friend, invited to say good-bye, excused himself on the ground that he had to go shopping with his mother. Another prop on which he leaned also precipitated him into the Slough of Despond. His ambition pointed to political distinction, and having given fair youthful proof of the power he felt to be in him, his pride taught him to look for a warm welcome from his party chiefs when he came of age, but on the contrary, there was a haggle over his admission. Lord Carlisle held coldly aloof, and he had to wait with savage indignation till the marriage certificate of his grandfather was fished up in Cornwall before he could take his seat. This cold but perfectly correct and formal indifference added another pang to the bitterness with which he took leave of his country. When after two years' absence he returned, still dogged by impecuniosity and the incivilities, real and imagined, that follow in its train, he "found fresh cause to roam." Nursed as he had been in superstitions, he could hardly keep from crying out that the stars had combined against him, when in the months following his return friend after friend went to the grave. Matthews was drowned in the Cam; Wingfield died of fever at Coimbra; and he heard of both deaths on the same day. His mother died in the same month, and in spite of all their quarrels, he felt the bereavement bitterly.

But the death which most deeply wounded him came later. Nothing ever racked him with sharper anguish than the death of her whom he mourned under the name of Thyrza. To know the bitterness of his struggle with this sorrow, we have only to look at what he wrote on the day that the news reached him (October 11, 1811); some of his wildest and most fiercely misanthropical verse, as well as some of his sweetest and saddest, belongs to that blackest of dates in his calendar. It is time that something were done to trace this attachment, which has been strangely overlooked by the essayists and biographers, because it furnishes an important clue to Byron's character, and is, indeed, of hardly less importance than his later attachment to the Countess Guiccioli. Mr John Morley, in an essay which ought to be read by everybody who wishes to form a clear idea of Byron's poetry as a revolutionary force in itself and an index to the movement of the time, remarks upon the respect which Byron, with all his raillery of the married state in modern society, still shows for the domestic idea. It is against the artificial union, the marriage of convenience, that Byron's raillery is directed; he always upholds singleness of attachment as an ideal, however cynically or mournfully he laments its infrequence, and points with laughter or with tears at the way in which it is crossed and cut short by circumstances when it does exist. Byron is not a railer against matrimony, except as a counterfeit of the natural union of hearts. His attachment to Thyrza shows that in this, as in other matters, he was transparently sincere. It is commonly taken for granted that his youth before, and, indeed, after his marriage with Miss Milbanke, was a featureless level of promiscuous debauchery; but those who look more narrowly into the facts cannot fail to see that, whatever may have been the number of his "light of loves,"—his fugitive passions were innumerable,—and however often he may have lapsed into vulgar rakery in bitter despair or reckless wantonness, he was always pining for some constant love, and cursing the fate that had denied it to him. This purer sentiment was always enshrined in his heart of heart, from his boyhood to the end of his days. Who Thyrza was can probably never be known, but in trying to convey the impression that she was merely imaginary, probably with the intention of shielding his friend's memory, by declaring him innocent of a relationship unsanctioned by society, Moore really did Byron an injustice. The poor girl, whoever she was, and however much she was deified after her death by his imagination, would really seem to have been his grand passion. Her "dear sacred name" his hand, he says years afterwards, would have trembled to write; he wished it to "rest ever unrevealed;" and when he was questioned by the Countess Guiccioli, he was deeply agitated, and begged her not to recur to the subject. We find him in his *Journal*, with her in his memory, writing with contempt of the amours of some of his acquaintances, and scoffing at the idea of their applying the name of love to favours that could be purchased. She is the presiding genius of his series of *Eastern Tales;* he has recorded the fact that when he drew the portrait of Zuleika his whole soul was full of her memory, and her image was again before him when he described the relationship between Zara and the disguised Gulnare. Conrad, with all his conscious villany, had one redeeming passion—"love unchangeable, unchanged." The Giaour, too, loved but one; he learnt that lesson, he said, from the birds; he despised "the fool still prone to range," and "envied not his varied joys." All these portraitures of single-hearted devotion are tributes to the memory of Thyrza, the "more than friend," commemorated in the second canto of *Childe Harold.* Medora's song in the *Corsair,* "Deep in my soul that tender secret dwells," though not flawless as a lyric, is one of his most beautiful expressions of this mournful sentiment in a subdued key. When we realize how bitterly he lamented her death, and how he could not even bear to write her name, there seems some reason for believing that the mysterious object of Manfred's love and remorse is another of the forms that she took in his imagination. Whoever cares to look into the matter will find many little corroborative particulars. It is quite in keeping with the morbid self-accusing tendency, the exaggerated moral sensibility, which Byron showed all his life through, that he should have been consumed with remorse at a recollection which colder-hearted men of the world bear about with them every day without a pang.

For some months after his return to England, Byron lived at Newstead very unhappily. He wrote that he was growing nervous, "really, wretchedly, ridiculously, fine-ladically nervous." He could not arrange his thoughts; he feared his brain was giving way, and it would end in madness. He felt at times a strange tendency to mirth. Sometimes he thought of seeking relief in a warfare against society, and he besought one of his friends, when he heard of his deepening crimes, to remember the cause. The inconsistency between this hunger for sympathy and the reckless ferocity of the resolution, shows how distempered his mind was by care and sorrow, "like sweet bells jangled, harsh, and out of tune." At other times he thought more soberly of parliament as a diversion. All his life through, however, "most of his convulsions ended in verse." He found occupation in correcting the proof-sheets of *Childe Harold.* He went up to London, not to plunge into a lawless and pitiless course of crime, but to enter upon a political career. He spoke two or three times in the House of Lords on the House-Breaker's Bill, and a petition for Roman Catholic Emancipation, but the publication of *Childe Harold* put an end at once to his parliamentary ambitions. "When *Childe Harold* was published," he says, "nobody thought of my prose afterwards, nor indeed did I."

It has often been asked what was the cause of the instantaneous and wide-spread popularity of *Childe Harold,*

which Byron himself so well expressed in the saying, "I awoke one morning and found myself famous." Chief among the secondary causes was the warm sympathy between the poet and his readers, the direct interest of his theme for the time. In the spring of 1812 England was in the very crisis of a struggle for existence. It was just before Napoleon set out for Moscow. An English army was standing on the defensive in Portugal, with difficulty holding its own; the nation was trembling for its safety. The dreaded Bonaparte's next movement was uncertain; it was feared that it might be against our own shores. Rumour was busy with alarms. All through the country men were arming and drilling for self-defence. The heart of England was beating high with patriotic resolution.

What were our poets doing in the midst of all this? Scott, then at the head of the tuneful brotherhood in popular favour, was celebrating the exploits of William of Deloraine and Marmion. Coleridge's *Christabel* was lying in manuscript. His poetic power was, as he said himself, "in a state of suspended animation." Southey was floundering in the dim sea of Hindu mythology. Rogers was content with his *Pleasures of Memory*. Wordsworth took a certain meditative interest in public affairs, but his poems, "dedicated to liberty," though fine as compositions, have not the fire and sinew, the ardent directness of popular verse. In the earlier stages of the war Campbell had electrified the country with his heart-stirring songs; but by 1812 he had retired from the post of Tyrtæus to become the poet of *Gertrude of Wyoming*. Moore confined himself to political squibs and wanton little lays for the boudoir. It was no wonder that, when at last a poet did appear whose impulses were not merely literary, who felt in what century he was living, whose artistic creations were throbbing with the life of his own age, a crowd at once gathered to hear the new singer. There was not a parish of Great Britain in which there was not some household that had a direct personal interest in the scene of the pilgrim's travels—"some friend, some brother there." The effect was not confined to England; Byron at once had all Europe as his audience, because he spoke to them on a theme in which they were all deeply concerned. He spoke to them, too, in language which was not merely a naked expression of their most intense feelings; the spell by which he held them was all the stronger that he lifted them with the irresistible power of his song above the passing anxieties of the moment. Loose and rambling as *Childe Harold* is, it yet had for the time an unconscious art; it entered the absorbing tumult of a hot and feverish struggle, and opened a way in the dark clouds gathering over the combatants through which they could see the blue vault and the shining stars. If the young poet had only thrown himself forward to ridicule the vanity of their struggles, he would most certainly have been spurned aside in the heat of the fight with anger and contempt; but he was far from being a heartless cynic; his sympathy with the Spanish peasant, his worship of the scenic wonders of the country, his admiration of the heroism of the women, his ardent battle-cry of freedom, burst through his thin pretence of cynicism. The pulse of heroism—heroism conscious of the worst that could happen, and undismayed by the prospect—beat beneath the garb of the cynic. It may have been by unconscious art, but it was not without dramatic propriety, that Byron turned in his second canto from the battlefields of Spain and the tremendous figure of war—

> "With blood-red tresses deepening in the sun,
> And death-shot glowing in his fiery hands—"

to "August Athena," "ancient of days," and the "vanished hero's lofty mound." In that terrible time of change, when every state in Europe was shaken to its foundation, there was a profound meaning in placing before men's eyes the departed greatness of Greece; it rounded off the troubled scene with dramatic propriety. Even the mournful scepticism of *Childe Harold* was not resented at a time when it lay at the root of every heart to ask, Is there a God in heaven to see such desolation, and withhold His hand?

The attention of the public once caught by his sympathy with them, it was rivetted by the theatrical fascination of the character of the pilgrim, whom they persisted in identifying with himself. Young, a man of genius, a lord, and unhappy—unhappy with a sorrow that could not be repressed,—here was a mystery over which speculation could never tire. On Byron himself the first effect of his fame was almost to endanger his poetic gift. He became acquainted with Moore, and went into the fashionable world as a "lion." He had never been in "society" before, and he took to gay life with all the impressionable facility of his character. He was even caught one evening by Mr Dallas in full court dress, and though he repented and did not go, this contemplated breach of his democratic principles, in gratitude for some kind words from the regent, shows how ductile his character was, and how easily he might have been lost to serious poetry if circumstances had not in his youth excluded him from the society of his rank. His docility under new influences was shown in the frank way in which he retracted hard saying after hard saying of his *English Bards*, and in the fact that though he was sufficiently scornful of the gay world to write the *Waltz* (1813), he strenuously denied the authorship. Yet he soon began to tire of fashionable gaieties and to long for solitude.

Byron's poetic power did not advance in strength during the four years of his connection with high life. As he had been led to employ the Spenserian stanza by Campbell's *Gertrude of Wyoming*, which reached his hands just as he was setting out on his travels, he began now to try the metres in which Scott had made his fame. He produced in rapid succession the *Giaour* (May 1813), the *Bride of Abydos* (December 1813), *Corsair* (January 1814), *Lara* (August 1814), *Siege of Corinth* (January 1816), *Parisina* (February 1816). The best of these is the first; but they were received with an enthusiasm which rose higher and higher with each successive publication. It is quite clear that it was against his intention that he had been identified with Childe Harold, but it is equally clear that though the self-restrained, stern, dark-browed heroes are personifications of only one side of his character, one series of moods, and are as unlike as possible to the complete Byron, he was not unwilling that they should be accepted as types of himself. There was another reason for this than a morbid desire to represent himself as worse than he really was. All Byron's friends from his boyhood upwards declare him to have been of a very shy disposition. Never having been in the fashionable world before the spring of 1812, he was far from being at his ease in it; and he masked his shyness under a haughty and reserved manner. How severe a restraint this was on his natural manner may be inferred from the delight with which he escaped from it in the society of his boon companions. It galled his vanity to be thus constrained by people for whom he had no great respect, and it is impossible to help conjecturing that he courted identification with his silent heroes, with their "vital scorn of all," and "chilling mystery of mien," in order to supply a romantic explanation of a reserve which was really due to unconquerable shyness. The influence of personal vanity on Lord Byron's actions, counterbalanced as it was and concealed by an equal warmth of generous feeling, is all but incredible. It was part of that amazing

sensitiveness to the impressions of the present which was the secret of much of the weakness of his character and much of the power of his poetry.

In November 1813 Byron proposed for the hand of Miss Milbanke, only daughter of Sir Ralph Milbanke, a wealthy baronet, and granddaughter and heiress of Lord Wentworth, "an eligible party," he owned in a letter to Moore, though he "did not address her with these views." His suit was rejected, but she expressed a desire to correspond with him. In September 1814 he made another proposal, which was accepted, and the marriage took place on January 2, 1815. On 10th December a daughter, named Augusta Ida, was born. On 15th January 1816 Lady Byron left her husband's house in London on a visit to her father at Kirkby Mallory. On the way she wrote an affectionate letter to Byron, beginning "Dear Duck," and signed "Your Pippin." A few days after he heard from her father that she had resolved never to return to him, and this intelligence was soon confirmed by a letter from herself. In the course of next month a formal deed of separation was drawn up and signed. This is Moore's account of the affair. Lady Byron's account, published on the appearance of Moore's *Life*, differs chiefly as regards the part taken by her parents in bringing about the separation. Byron suspected her mother's influence. Lady Byron took the whole responsibility on herself. Before she left town she thought Byron mad, and consulted Dr Baillie. Dr Baillie persuaded her that this was an illusion. She then told her parents that she desired a separation. The grounds on which she desired this were submitted by her mother to Dr Lushington, who wrote that they justified a separation; but advised a reconciliation. Then Lady Byron had an interview with Dr Lushington, and communicated certain facts, after which he declared a reconciliation impossible. A celebrated living authoress, who was slightly acquainted with Lady Byron, has, it is well known, made a definite statement on this subject, implicating a member of Lord Byron's own family. It is enough, however, to say that there is no evidence in support of the statement, and that it is virtually contradicted by Lady Byron's own behaviour, as she remained on intimate terms with the relative referred to after the separation from her husband.

The real causes of the separation between Byron and his wife must always remain more or less matter of debate, no absolute proof being possible, and disputants reasoning on the presumptions according to temperament and prepossession. Byron's own statement that "the causes were too simple ever to be found out," probably comes nearest the truth. That their tempers were incompatible, that without treating her with deliberate cruelty he tried her forbearance in many ways, and behaved as no husband ought to do, that for her own happiness she had every reason to demand a separation, will readily be believed. After his marriage a huge accumulation of debtors began to press their claims; no less than nine executions were put in force in his house during the year; and Byron, under the indignities to which he had daily to submit, acted with an insane violence which might have justified any woman in believing that she was not safe under the same roof with him. It would have required a very peculiar temper to be compatible with his under the circumstances. A placid, good-tempered woman, with strong good sense, and a boundless affection, which could forget and forgive his most unreasonable outbreaks, might have lived with him happily enough, finding in his sunny moods of playfulness and endearment ample compensation for his fits of gloominess and violence. But Lady Byron was very far from being a woman of that mould. A wife who could coldly ask Byron "when he meant to give up his bad habit of making verses," possessed a terrible power of annoying such a man; her perfect self-command and imperturbable outward serenity, her power of never forgetting an injury and taking revenge with angelic sweetness and apparent innocence of vindictive intention, must have been maddening. The serene way in which she clung to and promoted the maid, Mrs Clermont, in the face of Byron's intolerable dislike to the woman, was gall and wormwood to him. An even-tempered man might have lived with such a person comfortably on terms of mutual politeness; but for a haughty-tempered, violent, fitful, moody man it would have been impossible to find a more incompatible partner.

Why, at the time of the separation, did not the public look upon Byron and his wife as simply an ill-assorted pair who could not agree, and were better to separate? From the first it was rumoured that Lady Byron refused to tell the cause of their separation, whence the public naturally inferred that it must be too terrible to be revealed, and busied themselves inventing and circulating crimes of suitable magnitude. Retribution fell upon Byron for his identifying himself with crime-stained buccaneers. The publication, by an indiscreet friend, of his *Farewell to Lady Byron*, and the verses entitled *A Sketch*, let loose the flood-gates of popular indignation in the press. On the *Farewell* indeed, there was some difference of opinion. A lady correspondent of the *Courier* declared that "if her husband had bidden her such a farewell she could not have helped running into his arms and being reconciled immediately." If Lady Byron had been such a woman—we have no right to blame her because she was not—the separation, in all probability, would never have taken place. The vast majority in English society resented the publication of the *Farewell* as an unworthy attempt to put his wife in the wrong, by holding up her unforgiving temper for public reprobation. We now know that the *Farewell* was written in all sincerity and bitterness of heart, with the tears falling on the paper as he wrote, and that it was published by the indiscreet zeal of a friend to whom he had sent the verses. The fierce attack upon Mrs Clermont in the *Sketch* was universally condemned as unmanly. The two poems are chiefly interesting now as showing the poet's ungovernable incontinence, his passionate craving for sympathy, and the utter distemper of his mind in the bewilderment of misfortune.

Byron took final leave of England in April 1816. From that date the external events of his life, down to his memorable interference in the cause of Greek independence present comparatively little variety, and excite comparatively little interest. Nothing occurred after this to give a new turn or a new colour to his poetic career; the powerful influences which had conspired to torture music out of him were modified by the lapse of time, but very little, if at all, by the incidents of his life. The bitter feelings with which he left England, the angry sense of injustice and spirit of proud and revengeful defiance, alternating hysterically with humble self-reproach and generous forgiveness, passed into lighter forms, but they never ceased to rankle. Like Manfred, he asked in vain for oblivion.

In the thick of his troubles, before leaving England, Byron conceived that he had never been "in a situation so completely uprooting of present pleasure, or rational life for the future." But his going abroad was really a most fortunate step both for his happiness and for the exercise of his genius. Abroad he consented to the sale of Newstead, and his income enabled him to live without being subject to the constant indignities which were such a torture to him at home. There also he found the solitude which he had always desired. "Society," he wrote in a letter to Moore, "as now constituted, is *fatal* to all great original undertakings of every kind," and in his case certainly this was true. His first place of residence abroad was Diodati,

a villa in the neighbourhood of Geneva. He spent the summer there, making two excursions to Switzerland,—one with Hobhouse, a shorter one with Shelley, who also was living at Geneva at the time. His travels through Flanders past the field of Waterloo appear in the third canto of *Childe Harold* (May to July 1816); the idea of writing *Manfred* on his way to Geneva (begun September 1816, finished February 1817) occurred to him on the Jungfrau, where the scene is laid. In November 1816 he removed to Venice, and lived there, with the exception of short visits to Ferrara and Rome, till December 1819, writing fourth canto of *Childe Harold* (June 1817), *Beppo* (October 1817), *Ode to Venice* (July 1818), first canto of *Don Juan* (September 1818), *Mazeppa* (October 1818), second canto of *Don Juan* (December 1818), third and fourth cantos (finished November 1819). The bare catalogue of his literary work shows that the reports of the debauchery in which he lived at Venice, and from which he is said to have been rescued by the Countess Guiccioli, must be taken with a qualification. His acquaintance with this lady began in April 1819, and a mutual attachment sprang up at once. In December 1819 he removed to Ravenna. In the following month the Countess Guiccioli, having separated from her husband, occupied, under her father Count Gamba's presence and sanction, a suite of rooms in the same house with Byron at Ravenna; and though the families were formally separate, the union was not broken till Byron's departure for Greece. When, two years later, in 1821, the Gambas, in consequence of their connection with revolutionary movements, were ordered to quit Ravenna, Byron removed to Pisa and lived with them under the same roof as before. Leigh Hunt, who also was received into Byron's house with his wife and children, has given us a somewhat ill-natured but sufficiently faithful picture of his life here, which was simply that of a busy domesticated literary man, with a taste for riding, swimming, and marksmanship. During Byron's residence here Shelley was drowned in the Gulf of Spezzia. In September 1822, the Gambas were ordered by the Tuscan Government to quit Pisa, and Byron removed with them to Genoa. His life at Genoa has been described with traces of airy malice, but with much vivacity and abundance of detail, by Lady Blessington.

While he lived with the Countess Guiccioli Byron's literary industry was prodigious. The following is the list:—Translation of the first canto of *Morgante Maggiore*, February 1820; the *Prophecy of Dante*, March 1820; translation of *Francesca de Rimini*, March 1820; *Marino Faliero*, April to July, 1820; fifth canto of *Don Juan*, October to November 1820; *The Blues*, November 1820; *Sardanapalus*, January to May 1821; *Letters on Bowles*, February and March 1821; *The Two Foscari*, June to July 1821; *Cain*, July to September 1821; *Vision of Judgment*, September 1821; *Heaven and Earth*, October 1821; *Werner*, November 1821 to January 1822; *Deformed Transformed*, begun November 1821, finished August 1822; *Don Juan*, sixth, seventh, and eighth cantos, February 1822; ninth, tenth, and eleventh cantos, August 1822; *The Age of Bronze*, January 1823; *The Island*, February 1823; *Don Juan*, twelfth and thirteenth cantos, February 1823.

This quiet industrious life, however, did not cure him of his constitutional melancholy and restlessness. The curse of his nature was that he exhausted his pleasures too quickly. He too soon became dissatisfied with past triumphs. Much as he enjoyed the success of the works which poured with such rapidity from his pen, he began to harp on what he might have done; began to think that the tide was turning against him in England, and to hunger for new distinction. In this spirit, towards the end of 1821 he commenced those negotiations for the publication of a journal in England in conjunction with Shelley and Leigh Hunt, which ended in the abortive *Liberal*. The *Vision of Judgment*, the greatest of modern satires, appeared in the first number of the *Liberal*, in the summer of 1822; only three more numbers were published. According to Moore, the sign of an intention to take an active part in alliance with English Radicalism did more to make Byron unpopular in England than the most shocking of his poems. It was fortunate for his popularity that a more glorious enterprise offered itself to him in the Greek struggle for independence. He was brought into connection with this through the London Greek committee, of which he was appointed a member in May 1823. He at once decided to take action, raised 50,000 crowns, bought an English brig of 120 tons, and sailed from Genoa with arms and ammunition in July. The high hopes with which he set out were soon broken down; the Greeks had no plans, and he was compelled to spend five months of inglorious delay at Cephalonia. Reaching Missolonghi in December, after a chase by Turkish cruisers, he found dissension among the Greek chiefs and insubordination among their followers. He was appointed commander-in-chief of an expedition against Lepanto; but before anything could be done he was seized with fever, and died on the 19th April 1824.

It is yet, perhaps, too soon to hazard a speculation as to the permanence of Byron's fame. That he holds a lower place in the opinion of the present generation than of his own, so far at least as concerns his own country, is undeniable, and is probably due to the fact that poets now are tried by more strictly artistic standards; verses are judged, proportions measured, rare and precious excellences appreciated with the jealous scrutiny and skilled recognition of professional workmen. Tried by such standards, Coleridge, Keats, and Shelley must be pronounced Byron's superiors. The greatest modern authority on verse, Mr Swinburne, comments justly on Byron's imperfect mastery of his materials:—"One native and incurable defect grew up and strengthened side by side with his noblest qualities—a feeble and faulty sense of metre. No poet of equal or inferior rank ever had so bad an ear. His smoother cadences are often vulgar and facile; his fresher notes are often incomplete and inharmonious. His verse stumbles and jingles, stammers and halts, where is most need for a swift and even pace of musical sound. The rough sonorous changes of the songs in *The Deformed Transformed* rise far higher in harmony, and strike far deeper into the memory than the lax, easy lines in which he at first indulged; but they slip too readily into notes as rude and weak as the rhymeless, tuneless verse in which they are so loosely set, as in a cheap and casual frame. The magnificent lyric measures of *Heaven and Earth* are defaced by the coarse obtrusion of short lines with jagged edges—no small offence in a writer of verse." In point of metre, too, Byron showed none of the originality which we should expect in a poet who delighted in his materials for their own sake. The god of his idolatry was Pope, towards whom his sympathies were drawn chiefly by the elder poet's modern and practical point of view, and quick interest in passing affairs, and he began by imitating with very indifferent success Pope's satiric couplet. But his successes were achieved in more popular measures. He was the least possible of an antiquarian poet, whether in matter or in form. His way was to take up any measure that struck him as effective, and try his hand on it. Campbell's example suggested the Spenserian stanza; Scott and Coleridge the rapid octosyllables of his *Eastern Tales*; and he would never have thought of the *ottava rima* of *Beppo* and *Don Juan* but for Frere's *Whistlecraft*. *Whistlecraft* appeared in 1817, and the moment it fell into his hands Byron

recognized the value of the instrument, and lost no time in making it his own.

It was not on the artistic side that Byron's strength lay. Words were far from niggardly in their supplies to him: they flowed in upon him with sufficient readiness for free and direct expression; his thoughts were not blunted, his conceptions were not turned awry by hopeless struggling with stubborn material, but language was not pliant in his hands for the finer achievements of art. The truth is, he felt too deeply to be a poet of the very highest rank; the feeling of the moment took too large and embarrassing a hold of him to leave his hand free for triumphs of execution. This interfered both with the perfecting of details, and with the severe ordering of parts into an artistic whole. In Byron we are always struck more with the matter than with the form. It is his theme that absorbs attention, and the impetuous vehemence and stormy play of passion with which he hurries it on. This is, doubtless, an insecure foundation for lasting fame. The work of a man so keenly alive to the impressions of the hour, so closely bound up with his generation as Byron, runs a risk of perishing when the things that most deeply stir that generation have ceased to stir mankind. The secret of his tremendous power was his passionate sympathy with his own time. By the accidents of birth and circumstances, he was placed in opposition to the existing order of things, and his daring temper made him the exponent of the spirit of revolution. He is the greatest modern preacher of "liberty, equality, and fraternity." His little aristocratic assumptions were as superficial as his professions of antiquarian poetic loyalty. Nothing irritated him more than to deny him any of the privileges of his rank, but he never used the advantage of his social superiority in any of the contests in which he was involved, and in his loves and his friendships he showed regard only for the individual. He was a warm champion of the established fame of Pope against innovators, but he practised the innovations himself with such effect that he has been called—a foolish enough phrase, certainly, but intelligible—"the interpreter of Wordsworth to the multitude." Abroad, Byron's influence was, from the appearance of *Childe Harold*, no less conspicuous than at home. It has even been said that he was the first Englishman who made English literature known throughout Europe. Even such men as Lamartine, who deplored Byron as an incarnation of Satan, acknowledged his power; Lamartine says that Byron was "a second Ossian to him," and tells us that he was afraid to read him in his youth lest he should be perverted to his beliefs. Heine invited the compliment of being called "the German Byron." He is believed to have largely influenced the revolutionary movement in Germany, and he gave a direct stimulus to the liberators of Italy. Byron is the favourite poet of our English speaking fellow-subjects in India; the educated Bengalee knows him by heart. On the Continent his influence has rather increased than diminished. Only the other year a glowing eulogy of his genius was written by Castelar, the literary leader of republicanism in Spain. At home of late we have been accused of neglecting Byron, and the fact is significant. Such stormful and melancholy poetry as his must always be at the height of its popularity in times of conflict. The disturbed state of the Continent is more favourable to its spirit than the piping times of peace which have prevailed for a generation in England. Men who are content with the old things, and men who renounce old things with a light heart, can have little affinity with his deep-rooted sadness, his pride of defiant struggle, his flashes of defiant merriment; all this seems hysterical, affected, and unreal,—and unreal it no doubt is, in the sense that the feelings of men under the tension of conflict must appear full of false notes to men who look on out of a normal condition of settled tranquillity.

The most hopeful circumstance for the permanence of Byron's name is that he stands at the opening of a new era as its largest literary figure. Sooner or later, as new phases of thought and sentiment supervene upon the old, his writings must pass out of the catalogue of popular literature, but his personality will always fascinate. He is like Hamlet in this respect. It may safely be predicted that Byron will not cease to be read till Hamlet has ceased to be studied. There is not a little in common between the characters, in spite of superficial difference. In the desolation of his youth, in his moodiness, in his distempered mobility between the extremes of laughter and tears, in his yearning for sympathy, his intensity of friendship, his dark fits of misanthropy, his habit of brooding over the mysteries of life, Byron unconsciously played the character of Hamlet with the world for his stage, and left a kindred problem for the wonder of mankind,—a problem which no analysis can make clear, and which every one may pray that it be not given them to understand.

It has often been said that Byron could draw but one character, and that his own This is not more than a half truth. It is true that Byron's genius was more lyrical than dramatic. "Many people," he said himself, "think my talent *essentially undramatic*, and I am not clear that they are not in the right." But he also said that while he, "like all imaginative men, embodied himself with the character while he drew it," he did so "not a moment after the pen was from off the paper." The difference between saying that Byron loved to picture himself in various circumstances, and that he could not set himself to the artistic portraiture of any character in which he was not interested, may not be great, but it is the difference between a true view and a false view of his artistic method. He was undramatic in this sense, that his imagination did not enter freely and self-delightedly into various forms of life. When Moore thought he had found a beautiful subject for Byron's genius, and wrote the details to him, Byron could not enter into the situation. His *Monody on Sheridan* is weak, because it was not spontaneous. But when he found a situation or a character which naturally attracted him, and which he was able to understand, his method was not, as is implied by the language in which his want of dramatic faculty is often expressed, to bring the situation or the character nearer to his own experience, but he tried to identify himself with the life of his subject, and laboured at details with almost pre-Raphaelitic minuteness. We do right to call him undramatic still, because a dramatic genius is doing constantly and by the law of his nature what Byron could only do rarely and with a limited range. But it is wrong to say that he was always drawing himself. There are considerable intervals between Sardanapalus, Marino Faliero, Alp, Lara, and Manfred, although in those and in all his leading characters we are more struck with what they have in common with their author, the affinity that led him to deal with their fortunes, than we are with their separate individualities. The Countess Guiccioli has given in the case of Marino Faliero a good example of the way in which he prepared himself for his work. He was struck with the tradition of Faliero's conspiracy in his old age against the state which he had served so well in youth and middle age, immediately after his arrival in Venice, but at first he was unable to satisfy himself as to the motive. The ordinary histories, which he searched through with care, ascribed it to an old man's jealousy of a young wife, but this Byron's instinct rejected. He passed hours in the hall of the great council, stared at the record of Faliero's decapitation, lingered about the tomb, and called up and realized every recorded circumstance of his life, keenly

studied the characters of living Venice. It was not till four years afterwards that he satisfied himself as to the motive, and the discovery of an old document afterwards proved that his reading of history was correct. In other cases he showed the same studious care for accuracy, the very opposite of rash and dashing identification of characters with himself. In most of his tales and dramas there is an historical basis, and the basis is scrupulously ascertained. He particularly prided himself upon the truth of his local colouring.

The most interesting and complete portrait of Byron is perhaps that drawn by Lady Blessington, who saw him at Genoa a few months before his departure for Greece. It is not so favourable as some, but it is peculiarly valuable because taken from a definite point of view, that of a clever woman of the world and practised critic of appearance and manner. "I had fancied him," she says, "taller, with a more dignified and commanding air, and I looked in vain for the hero-looking sort of person with whom I had so long identified him in imagination. His appearance is, however, highly prepossessing, his head is finely shaped, and the forehead open, high, and noble, his eyes are grey and full of expression, but one is visibly larger than the other, his mouth is the most remarkable feature in his face, the upper lip of Grecian shortness, and the corners descending, the lips full and finely-cut. In speaking he shows his teeth very much, and they are white and even, but I observed that even in his smile—and he smiles frequently—there is something of a scornful expression in his mouth that is evidently natural, and not, as many suppose, affected. . . . His countenance is full of expression, and changes with the subject of conversation; it gains on the beholder the more it is seen, and leaves an agreeable impression. . . . He is very slightly lame, and the deformity of his foot is so little remarkable that I am not now aware which foot it is. His voice and accent are peculiarly agreeable, but effeminate—clear, harmonious, and so distinct that, though his general tone in speaking is rather low than high, not a word is lost. . . . . I had expected to find him a dignified, cold, reserved, and haughty person, resembling those mysterious personages he so loves to paint in his works, and with whom he has been so often identified by the good-natured world, but nothing can be more different; for were I to point out the prominent defect of Lord Byron, I should say it was flippancy, and a total want of that natural self-possession and dignity which ought to characterize a man of birth and education." Such, judged by the social standard of his own country, was the look and personal manner of the greatest literary power of this century.

The best edition of Byron's works is that published by Murray, with illustrative extracts from his letters and diaries, and from the criticisms of his contemporaries. A selection from his works, edited and prefaced by Mr A. C. Swinburne, is published by Moxon. The facts of his life may be studied in Moore's *Life, Letters, and Journal of Lord Byron*, supplemented by Leigh Hunt's *Lord Byron and his Contemporaries*, Lady Blessington's *Conversations with Lord Byron*, Trelawney's *Recollections of Shelley and Byron*, and the Countess Guiccioli's *Lord Byron jugé par les témoins de sa vie* (translated under the title of *Recollections of Lord Byron*). Numerous allusions to Byron occur in the published memoirs of his contemporaries, such as the *Shelley Memorials* and Crabb Robinson's *Diary*. Karl Elze's biography (translated), although often mistaken in its conception of his character, is valuable as a collection of facts. (W. M.)

BYRON, Hon. John (1723–1786), admiral and circumnavigator, second son of the fourth Lord Byron, and grandfather of the poet, was born November 8, 1723. While still very young accompanied Anson in his voyage of discovery round the world. During many successive years he saw a great deal of hard service, and so constantly had he to contend, on his various expeditions, with adverse gales and dangerous storms, that he was aptly nicknamed by the sailors, "Foul-weather Jack." It is to this that Lord Byron alludes in his famous *Epistle to Augusta*:—

> "A strange doom is thy father's son's, and past
> Recalling as it lies beyond redress,
> Reversed for him our grandsire's fate of yore,
> He had no rest at sea, nor I on shore.

In 1769 he was appointed governor of Newfoundland. In 1775 he attained his flag rank, and in the following year became a vice-admiral. In 1778 he was despatched with a fleet to watch the movements of the Count d'Estaing, and in July 1779 fought an indecisive engagement with him off Grenada. He soon after returned to England, retiring into private life, and died April 10, 1786.

BYSTRÖM, Johann Nicolaus (1783–1848), Swedish sculptor, was born December 18, 1783, at Philipstad. At the age of twenty he proceeded to Stockholm and studied for three years under Sergell. In 1809 he gained the academy prize, and in the following year visited Rome. He sent home a beautiful work, The Reclining Bacchante, in half life size, which raised him at once to the first rank among Swedish sculptors. Oh his return to Stockholm in 1816 he presented the crown prince with a colossal statue of himself, and was entrusted with several important works. Although he was appointed professor of sculpture at the academy, he soon returned to Italy, and with the exception of the years from 1838 to 1844 continued to reside there. He died at Rome in 1848. Among Byström's numerous productions the best are his representations of the female form, such as Hebe, Pandora, Juno suckling Hercules, and the Girl entering the Bath. His colossal statues of the Swedish kings are also much admired.

BYZANTINE EMPIRE. See Greek Empire.

BYZANTINE HISTORIANS. The historians who have related the transactions under the Eastern, Greek, or Byzantine empire, for the millennium intervening between the death of Theodosius and the Turkish conquest of Constantinople, are collectively classed together under the above designation. Until, however, the middle of the 6th century, they are, with one conspicuous exception, too merely fragmentary to deserve special notice. This exception is Procopius, the Polybius of his age, whose histories are of such importance as to demand a separate article. We shall arrange his successors in chronological order, distinguishing between the historians properly so called and the chronologers.

Historians.—I. Agathias of Myrina in *Ætolia*, was born under Justinian, about 536 A.D., and is believed to have died under Tiberius the Second, about 580. His character as an epigrammatist and an editor of poetry has been already considered under the head Anthology. We are indebted to him in his historical capacity for an extremely valuable narrative of six of the most eventful years of the Greek empire, 553–558. The first book details the conquest of Italy from the Goths by Justinian's general Narses; the remainder describe, along with other incidents, the Persian war of 554–556, the two great earthquakes of 554 and 557, the great plague, the rebuilding of St Sophia, and Belisarius's last exploits against the Bulgarians. The history terminates abruptly, and was probably left unfinished. As a narrator, Agathias is sensible and impartial, but deficient in general knowledge, and far below the standard of a philosophic historian. His style is rhetorical, but not unpleasing. II. Menander Protector, the far inferior imitator of Agathias, lived under Mauricius, whose reign began in 581, and continued the history of Agathias to the date of the accession of that emperor. His work was comprised in eight books, which are entirely lost, with the exception of numerous extracts relating to embassies preserved in the collection Περὶ πρεσβειῶν—the 27th and only existing book of the extensive compilation of historical excerpts made by the Emperor Constantine Porphyrogenitus.

III. THEOPHYLACTUS of Simocatta, a sophist and civilian of Egyptian extraction, wrote the history of the Emperor Mauricius (582–602) in eight books, all of which are preserved. The work seems to have been completed under Heraclius. Theophylactus lived until 628 or 629. He is an accurate and not inelegant writer, but frequently trivial and frigid. IV. JOANNES of Epiphaneia, a contemporary of Theophylactus, wrote the history of the wars of the Greeks and Persians from the latter part of Justinian's reign until the restoration of Chosroes II. by Mauricius (591). His history has never been printed, but is said to exist in MS. at Heidelberg. V. The Emperor CONSTANTINE PORPHYROGENITUS (reigned 911–959). Among the many services rendered to literature by this learned sovereign is to be enumerated his history of his grandfather Basil the Macedonian, emperor from 867 to 886. VI. GENESIUS, who lived in the time of Constantine Porphyrogenitus, wrote by his order the history of Basil II. and of his four immediate predecessors (813–886). The work is brief and meagre, but is almost the only authority we possess for a portion of the period described. VII. JOANNES CAMENIATA, a native of Thessalonica, and cross-bearer to the archbishop, wrote an account, which has been preserved, of the sack of that wealthy city by the Saracens in 904. Cameniata himself was one of the captives, and his narrative is very lively and valuable. VIII. LEO DIACONUS, an ecclesiastic in the latter half of the 10th century, is the author of an indifferently written, but honest and instructive, narrative of the remarkable period of national recovery under the emperors Romanus II., Nicephorus Phocas, and John Zimisces, when Crete was reconquered, Syria invaded, and the Russians driven out of Bulgaria (959–975). Leo wrote at least as late as 993. IX. NICEPHORUS BRYENNIUS, the son-in-law of the Emperor Alexius Comnenus, and one of the first statesmen and generals of his time, wrote in four books the history of the empire under the Comneni from 1057 to 1081. X. His still more celebrated wife, ANNA COMNENA, daughter of the Emperor Alexius, and the marvel of her sex at that extremely low period of female education, wrote (1148) the history of her father in fifteen books. The period of Alexius is peculiarly interesting as that in which the barrier of Byzantine isolation was broken down, and the East and West brought into contact by the encroachments of the Normans on the Eastern empire and by the Crusades. We cannot be too grateful to the Princess Anna for her vivid sketch of the arrival of the Crusaders at Constantinople, and the relations between them and the Byzantine court. Her work, however, must be used with great caution. Gibbon's employment of it is an example of his usual discernment. XI. Her history was continued by JOANNES CINNAMUS, one of the most eminent of all the Byzantine historians. He was one of the imperial notaries under the reign of Manuel Comnenus (1143–1180), an office nearly corresponding to that of a modern secretary of state. He had, consequently, great administrative experience, and a thorough knowledge of the relations of the empire with foreign states, and of the internal affairs of the latter. He is thus in an excellent position for writing history, besides which his own judgment and sagacity are of a very superior order, and his style is commonly terse and clear. Like most writers who have themselves participated in the transactions they describe, he is not altogether exempt from partiality. His history comprehends the period from the death of Alexius Comnenus in 1118 to the siege of Iconium by Manuel Comnenus in 1176, four years before the death of that emperor. There is little doubt that Cinnamus brought his work down to the close of Manuel's reign, and that the conclusion is lost. XII. NICETAS ACOMINATUS, or CHONIATES, a patrician and holder of many important public offices under the emperor Isaac Angelus at the beginning of the 13th century, described the same period as Cinnamus, but continued his narrative to 1206. The latter books of Nicetas's history possess especial importance, inasmuch as they contain the Byzantine account of the taking of Constantinople by the Latins in the fourth crusade (1204). Nicetas's own palace was burned and plundered, and he escaped with difficulty to Nicæa, where he composed his history under the protection of the emperor Theodore Lascaris. His narrative, though too rhetorical, is striking and pathetic; it necessarily requires careful comparison with the Latin accounts. The remainder of his history is also valuable. He is also said to be the author of an account of the statues destroyed by the Latins, which, however, is thought to have been interpolated by a later writer. It has been published by Wilken (Leipsic, 1830). XIII. GEORGIUS ACROPOLITA, an eminent scholar and diplomatist, who lived from 1220–1282, wrote the history of the Eastern empire during its subjugation by the Latins (1204–1261). The work is so brief that it has been regarded as merely an epitome of Acropolita's original history. XIV. GEORGIUS PACHYMERES, a priest and ecclesiastical jurist under Michael and Andronicus Palæologus, wrote the history of these emperors (1258–1308) in thirteen books. Pachymeres is one of the best of the Byzantine historians; his style is singularly good for his age, and his tone dignified and impartial. XV. NICEPHORUS GREGORAS, a man of great learning, but passionate and untrustworthy as an historian, wrote the history of his country from 1204–1358, in thirty-eight books, the last fourteen of which remained unpublished until 1855, when they were edited at Bonn by Immanuel Bekker. After the recovery of Constantinople by the Greeks in 1261, Byzantine politics entered into a new phase; the feeble and distracted empire, unable to make head against the Turks, was compelled to lean for support upon the European powers, which it sought to obtain by patching up the long-standing religious schism. Greeks and Latins, however, were equally resolved to concede nothing save in appearance, and the history of the time is to a great extent that of hollow negotiations, meant only to deceive. In these Gregoras had a considerable share; he also took an active part in the internal religious controversies of his church, and his personal knowledge of affairs imparts considerable value to his history. He was at one time a favourite of the Emperor Cantacuzenus, but was subsequently persecuted by him. He possessed extensive attainments, and is especially celebrated for having anticipated the astronomers of Pope Gregory XIII. in the correction of the Julian Calendar. XVI. The Emperor JOHN CANTACUZENUS, after his abdication, wrote the history of his times from 1320–1357, including the fifteen years of his own eventful reign. This "is written," as Dr Plate observes, "with elegance and dignity, and shows that the author was a man of superior intelligence, fully able to understand and judge of the great events of history;" but Gibbon's remark is no less just that Cantacuzenus "presents, not a confession, but an apology of the life of an ambitious statesman. Instead of unfolding the true counsels and characters of men, he displays the smooth and specious surface of events, highly varnished with his own praises and those of his friends." The truth is arrived at by a comparison of Cantacuzenus with the rival and inimical narrative of Nicephorus Gregoras, so far as they cover the same ground. XVII. JOANNES CANANUS wrote an account of the siege of Constantinople by Amurath II. in 1422; and XVIII. JOANNES ANAGNOSTES described the capture of Thessalonica by the same Sultan in 1430. XIX. MICHAEL DUCAS, the chief historian of the fall of the Greek empire, escaped from the sack of Constantinople

to Lesbos, where he entered into the service of the prince of that island, and wrote his history after the reduction of Lesbos by the Turks in 1462. It commences in 1342, and goes down to the conquest of Lesbos. Ducas is the most difficult and barbarous of all the Byzantine historians, and the only one who appears entirely unacquainted with classical models. At the same time he is among the most intelligent, impartial, and sagacious. The ruin of the Greek empire has also been recorded by XX. Georgius Phrantzes and XXI. Laonicus Chalcocondyles Both of these were eminent among the statesmen of their disastrous period, and Phrantzes in particular played a very important part in diplomacy. Broken hearted at the capture of his native city and the death of his son and daughter in slavery, he retired to a monastery in Corfu, where he wrote his *Chronicon* about 1477, to which year it extends. It commences at the year 1259, but by far the most valuable portion is that which records the transactions of the author's lifetime, and the value of this is very great. Chalcocondyles, beginning at 1298, brings his history down to the invasion of the Morea by the Turks in 1463. He also is an accomplished man, of much experience in public business; and although his digressions respecting the affairs and manners of other nations are irrelevant, and betray ignorance, they are interesting as an index to the knowledge possessed by his countrymen at his time.

II. Chroniclers and Chronologers.—The chronologers usually published in the Byzantine collection are frequently very valuable, but neither their lives nor their writings need detain us long. They are I. Georgius Syncellus, the attendant (*syncellus*) upon the patriarch Tarasius, about the beginning of the 9th century. His unfinished chronicle extends from Adam to Diocletian, and was continued to 813 A.D. by II. Theophanes Isaurus, a martyr in the cause of image worship. III. Leo Grammaticus and IV. Georgius Monachus continued Theophanes to 948 and 944 respectively. V. The chronicle of the Syrian Joannes Malalas extends from the beginning of the world to the year 566 Malalas is usually supposed to have lived in the 9th century, and to have left his work incomplete, but some regard him as contemporary of Justinian. VI. Nicephorus Patriarcha, Patriarch of Constantinople under Leo the Armenian, early in the 9th century, compiled a chronological history from the murder of the Emperor Mauricius to his own times, and an abridged chronological manual of events from the Creation. VII. Julius Pollux, a writer of the 10th century, compiled a chronology, chiefly of ecclesiastical occurrences, to the year 963, which has only been printed as far as the death of Valens (377). VIII. The contemporary chronicle of Hippolytus of Thebes is of little value. IX. The valuable *Chronicon Paschale*, which extends to 1042, is the work of three anonymous writers. There has been considerable difficulty in settling the respective claims to originality of X. Joannes Scylitza and XI. Georgius Cedrenus, but the latter was probably the copyist. The contrary opinion has prevented the publication of Scylitza's work, with the exception of the portions not transcribed by Cedrenus. These extend from 1057 to 1080. The chronicle of Cedrenus reaches from the Creation to the former of these dates. XII. The chronicle of Constantine Manasses is written in political verses, and extends from the beginning of the world to the accession of Alexius Comnenus in 1281. XIII. Michael Glycas, a writer of uncertain date, published a general chronology down to the year 1118. XIV. The abbreviated chronicle of Joel reaches the capture of Constantinople by the Latins in 1204 XV. The chronicle of Georgius Codinus, a writer of the 15th century, comes down to the capture of Constantinople, and is associated with a compilation respecting the antiquities of the city, which is of much greater value.

The contribution of the Byzantine historians to literature may be compared with the part enacted by the Byzantine empire in the history of the world. That empire added nothing to the treasures of civilization, but it preserved much. Like the earth in winter, it seemed barren and unlovely, but it kept the good seed hidden in its bosom for better days. Had it perished before the intellectual revival of Western Europe, the solution of continuity between ancient and modern culture would have been irreparable. In like manner the Byzantine historians preserved the traditions of historical composition, while their brethren of the West were merely chroniclers and annalists. They have safely embalmed in their generally unattractive pages a vast mass of most valuable information, for which we are in most cases solely dependent upon them, and they aid us to reconstruct the polity, and to some extent the social life, of what was for several centuries the only really civilized Christian state in the world. They are undoubtedly for the most part perfectly ignorant of the significance of their own times; they have postponed what was really interesting to barren details of battles and court intrigues, and have wasted opportunities which would have been invaluable to a philosophic historian. Cinnamus and Ducas are the only two with any claim to this character, and Anna Comnena is the only artist. When, however, all their disadvantages are taken into consideration, it will probably be deemed that they are much better than might have been expected. They were isolated from all the rest of the known world by prejudice, policy, and religious hatred. There was no scientific or other intellectual movement in their times, no aspiration for liberty, no conception of a more liberal culture; they were crushed by a rigid despotism, and enthralled by an abject superstition. Under these circumstances the good sense and sagacity of many among them are very remarkable, and are chiefly to be explained by the large proportion among them of men accustomed to practical life and public affairs. Their roll includes sovereigns, generals, prime ministers, secretaries of state, diplomatists, and other important public officers; even the ecclesiastics among them are not recluses but men versed in business. The Byzantine civil service was the strong point of the empire, and its solid if prosaic qualities are admirably reflected by its literary representatives.

The first collective edition of the Byzantine historians was published at Paris, 1648–1702, in 27 volumes, with a preface by Labbe, and notes and translations by Fabrotus, Combefisius, and others. It was reprinted, with additions, at Venice, 1729–33. These editions are superseded by the great edition of Bonn, 1828–55, in 48 volumes, undertaken at the recommendation and under the superintendence of Niebuhr, and continued after his death under the patronage of the Royal Prussian Academy. The separate volumes are edited by Bekker, Dindorf, Hase, and other distinguished scholars; nevertheless, according to Brunet, "de bons textes des historiens byzantins restent encore à donner." Like former collections it contains several works of value not strictly belonging to Byzantine history, but illustrative of it. No guide to Byzantine history is comparable to Gibbon, whose narrative of this period is an unparalleled literary feat of masterly and impartial condensation. See likewise Lebeau, *Histoire du Bas Empire*, Paris, 1824–36. Mr Finlay's volumes are also invaluable companions to the Byzantine historians. Of special works on the subject, the most important is Hankius, *De Byzantinarum rerum scriptoribus Græcis*, Leipsic, 1677, a book distinguished by extensive and accurate erudition, but necessarily deficient as respects the writers not published in the author's day. It contains notices of Byzantine ecclesiastical writers also. Special points of interest are discussed in Von Hammer's essay in the Göttingen *Annals*, (vol. 6) on the correction of the Byzantine historians from Ottoman sources; in Heyne's *Antiquatates Byzantinæ* (1808–11); and in Hullman's *Geschichte des Byzantinischen Handels* (1808). Sabatier's great work on Byzantine numismatics also affords much illustrative matter, and there is a lively sketch of the general social condition of the Eastern Empire in Augustin Marrast's *Esquisses Byzantines* (Paris, 1874.) (R. G.)

BYZANTIUM, an ancient Greek city on the shores of the Bosphorus, occupied the most easterly of the seven hills on which the modern Constantinople has been built. It is said to have been founded by a band of Megarians, 667 B.C., but the original settlement having been destroyed in the reign of Darius Hystaspes by the Satrap Otanes, it was recolonized by Pausanias, who wrested it from the hands of the Medes after the battle of Platæa (479 B.C.)—a circumstance which has led several ancient chroniclers to ascribe its foundation to him. Its situation, said to have been fixed by the oracle of Apollo, was remarkable for beauty and security. Its position on the Bosphorus gave it complete control over the extensive corn-trade carried on by the merchants of the West with the northern shores of the Euxine; the absence of tides and the depth of its harbour rendered its quays accessible to vessels of large burden; while the tunny and other fisheries at the mouth of the Lycus were so lucrative as to procure for the deeply-curved bay into which that river fell the appellation of the Golden Horn. The greatest hindrance to its continued prosperity consisted in the miscellaneous character of the population, partly Lacedæmonian and partly Athenian, who flocked to it under Pausanias. From this circumstance it was a subject of dispute between these states, and was alternately in the possession of each, till it achieved its independence of both only to fall into the hands of the Macedonians; and from the same cause arose the violent contests of its intestine factions, which ended in the establishment of a rude and turbulent democracy. About seven years after its second colonization, Cimon wrested it from the Lacedæmonians; but in 440 B.C., it revolted and returned to its former allegiance. Alcibiades, after a severe blockade (408 B.C.), gained possession of the city through the treachery of the Athenian party; and it continued an ally of Athens until 405 B.C., when it was retaken by Lysander after the battle of Ægos-potami, and placed under a Spartan harmost. It was under the Lacedæmonian power when the Ten Thousand, exasperated by the conduct of the governor, made themselves masters of the city, and would have pillaged it had they not been repressed by the firmness and promptitude of Xenophon. In 390 B.C. Thrasybulus, with the assistance of Heraclides and Archebius, succeeded in expelling the Lacedæmonian oligarchy, and in restoring democracy and the Athenian influence both in Byzantium and Chalcedon. After having withstood an attempt under Epaminondas to restore it to the Lacedæmonians, Byzantium joined with Rhodes, Chios, Cos, and Mausolus, king of Caria, in throwing off the yoke of Athens, but soon after sought Athenian assistance when Philip of Macedon, having overrun Thrace, advanced against it. The succours which were sent from Athens under Chares, on their arrival suffered a severe defeat from Amyntas, the Macedonian admiral, but in the following year gained a decisive victory under Phocion, and compelled Philip to raise the siege. The deliverance of the besieged from a surprise, by means of a flash of light which revealed the advancing masses of the Macedonian army, has rendered this siege peculiarly memorable. As a memorial of the miraculous interference the Byzantines erected an altar to Torch-bearing Hecate, and stamped a crescent on their coins as a symbol of the portent, a device which is retained by the Turks to this day. They also granted the Athenians extraordinary privileges, and erected a monument in honour of the event in a public part of the city. During the reign of Alexander, Byzantium was compelled to acknowledge the Macedonian supremacy; after the decay of the Macedonian power, it regained its independence, but suffered from the repeated incursions of the Scythians. The losses which they sustained by land roused the Byzantines to indemnify themselves on the vessels which still crowded the harbour, and the merchantmen which cleared the straits; but this had the effect of provoking a war with the neighbouring naval powers. The exchequer being drained by the payment of 10,000 pieces of gold to buy off the Gauls who had invaded their territories about 279 B.C., and by the imposition of an annual tribute which was ultimately raised to 80 talents, they were compelled to exact a toll on all the ships which passed the Bosphorus,—a measure which the Rhodians resented and avenged by a war, wherein the Byzantines were defeated. The retreat of the Gauls enabled Byzantium to render considerable services to Rome in the contests with Philip II., Antiochus, and Mithridates. During the first years of its alliance with Rome it held the rank of a free and confederate city; but having sought the arbitration of the capital on some of its domestic disputes, it was subjected to the imperial jurisdiction, and gradually stripped of its privileges, until reduced to the status of an ordinary Roman colony. In recollection of its former services, the Emperor Claudius remitted the heavy tribute which had been imposed on it; but the last remnant of its independence was taken away by Vespasian, who, in answer to a remonstrance from Apollonius of Tyana, taunted the inhabitants with having "forgotten to be free." During the civil wars, it espoused the party of Pescennius Niger; and though skilfully defended by the engineer Periscus, it was besieged and taken (196 A.D.) by Severus, who destroyed the city, demolished the famous wall, which was built of massive stones so closely rivetted together as to appear one block, put the principal inhabitants to the sword, and subjected the remainder to the Perinthians. This overthrow of Byzantium was a great loss to the empire, since it might have served as an effective protection against the Goths, who afterwards sailed past it into the Mediterranean. Severus, however, afterwards relented, and, rebuilding a large portion of the town, gave it the name of Augusta Antonina. He ornamented the city with baths, and surrounded the hippodrome with porticoes; but it was not till the time of Caracalla that it was restored to its former political privileges. It had scarcely begun to recover its former flourishing position when, from the capricious resentment of Gallienus, the inhabitants were once more put to the sword, and the town given up to be pillaged. From this disaster the inhabitants recovered so far as to be able to give an effectual check to an invasion of the Goths in the reign of Claudius II., and its fortifications were greatly strengthened during the civil wars which followed the abdication of Diocletian. Licinius, after his defeat before Adrianople, retired to Byzantium, where he was besieged by Constantine, and compelled to surrender. To check the inroads of the barbarians on the north of the Black Sea, Diocletian had resolved to transfer his capital to Nicomedia; but Constantine, struck with the advantages which the situation of Byzantium presented, resolved to build a new city there on the site of the old, and transfer the seat of government to it. The design was quickly put into execution, and the new capital was inaugurated with special ceremonies 330 A.D. See CONSTANTINOPLE.

The ancient historians invariably note the profligacy of the inhabitants of Byzantium. They are described as an idle and depraved people, spending their time for the most part in loitering about the harbour, or carousing over the fine wine of Maronea. In war they trembled at the sound of a trumpet, in peace they quaked before the shouting of their own demagogues; and during the assault of Philip II. they could only be prevailed on to man the walls by the savour of extempore cook-shops distributed along the ramparts. The modern Greeks attribute the introduction of Christianity into Byzantium to St Andrew; and it certainly had some hold there in the time of Severus.

C

C is the third letter of the English alphabet, and of the other alphabets derived from the Latin. Its history has been singular. It was the same in form as the Greek Γ, but inclined at a different angle, thus, ∠ (see under ALPHABET), and by degrees it was rounded into C. It occupied the same place in the alphabet, and had the same phonetic value,—that of the sonant guttural *g*, the corresponding surd being represented, as in Greek, by K. (See under B for the distinction between sonants and surds.) These two sounds became confused at Rome at an early time—before 450 B.C., and perhaps much earlier. The *k*-sound was lost and the symbol C represented both the *g*-sound, as in *macister*, *lecio*, and the original *k*-sound, as in *censor*, *consul*. The symbol K, however, was not entirely lost; it is found irregularly in inscriptions of all dates down to the times of the empire, and regularly as an initial abbreviation of *Kalendæ*, *Karthago*, *Kæso* (the proper name). In the 3d century B.C., the distinction between the two sounds was revived; but the symbol K was not replaced in ordinary use. C remained as the representative of the surd, losing its original sonant value; while a modification of it (G) was introduced to represent the sonant. The symbol retained its old value only when as the initial letter it represented the names *Gaius* and *Gnæus*,—which, in consequence, are often erroneously written and sounded *Caius* and *Cnæus*. With this changed value the symbol C passed into the languages which are represented by the Latin alphabet. In some of them it has undergone yet further change. Before *e* and *i* in Italian, though still written, it is sounded as *ch*. This change from the guttural to the palatal is the result of assimilation, due to the following vowels. There is no evidence to show that it was established before the 7th century A.D. In France (as commonly in England) *c* before *e* and *i* has the sound of *s*. This is only a further change in the same direction as the Italian; and before *a* in French an original *c* has the sound *sh*, and is spelt *ch*, as in *champ* (*campus*), *chambre* (*camera*). Exceptions to this rule are generally words incorporated into classical French (*i.e.*, the descendant of the old dialect of the Isle de France) from other dialects, as those of Normandy or Picardy, or are introduced from the Italian, as *cavalier*, &c. Our English *ch* (pronounced *tch*) for original *c* (as in *chin* for Old English *cin*, *child* for *cild*) is due probably to Norman influence, but here, as often, it is difficult to differentiate the results of the many disturbing causes which have operated upon our language.

As a numeral, C (for *centum*) denotes 100. In music, placed after the clef, it indicates that the measure is of the value of four crotchets.

CAABA. See KAABA and MECCA.

CABAGAN, a town of Luzon, one of the Philippine Islands, in the province of Cagayan, situated on the N.E. coast. It is the second largest city in the province, and has a population of 11,100.

CABANIS, PIERRE JEAN GEORGE (1757–1808), a distinguished French physiologist, was born at Cosnac in 1757. His father was a lawyer of eminence, and chief magistrate of a district in the Lower Limousin. His education was at first entrusted to the priests, but at the age of ten he was transferred to the College of Brives. He showed great aptitude for study, but his independence of spirit was so excessive that he was almost constantly in a state of rebellion against his teachers, and was finally dismissed from the school. After a year's residence at home he was taken to Paris by his father and left to carry on his studies at his own discretion. He attended classes at the university, and read with particular delight Locke's essay *On the Human Understanding*. Two years had been spent in close and assiduous study, when in 1773 he received the offer of the post of secretary to the prince-bishop of Wilna. He accepted it and passed two years at Warsaw, viewing with disgust and contempt the petty intrigues and jealousies that accompanied the first partition of Poland.

On his return to Paris he devoted himself mainly to poetry, for which he had always a strong inclination. He was intimate with the poet Roucher, and was introduced by Turgot to the society of Mme. Helvetius, where he met such men as Diderot, D'Alembert, D'Holbach, Condillac, Franklin, and Jefferson. About this time he ventured to send in to the Academy a translation of the passage from Homer proposed for their prize, and though his attempt passed without notice, he received so much encouragement from his friends that he contemplated translating the whole of the *Iliad*.

At the earnest desire of his father he relinquished these pleasant literary employments, and resolved to engage in some settled profession. After deliberation he fixed upon that of medicine, and began his studies under Dubreuil. In 1789 his *Observations sur les Hôpitaux* procured him an appointment as administrator of hospitals in Paris. From inclination and from weak health he never engaged much in practice as a physician. His interest lay entirely in the deeper problems of medical and physiological science, and these he investigated with unusual closeness and minuteness. Nor had he quite given up his fondness for literary society; his residence at Auteuil on the outskirts of the capital enabled him still to continue his intercourse with Diderot, Condillac, and others. He had even the pleasure of reading to Voltaire part of his translation of the *Iliad*, and of receiving warm commendation from the veteran critic. But he had long ceased to occupy himself with that work; and in his *Serment d'un Médecin*, which appeared in 1789, he bade a formal adieu to poetry.

In the great political struggle of the time Cabanis espoused with enthusiasm the cause of the Revolution, to which he was attached from principle, and of which the opening prospects were congenial to his active and ardent mind. During the two last years of Mirabeau's life he was intimately connected with that extraordinary man, who had the singular art of pressing into his service the pens of all his literary friends. Cabanis united himself with this disinterested association of labourers, and contributed the *Travail sur l'Education Publique*, a tract which was found among the papers of Mirabeau at his death, and was edited by the real author soon afterwards in 1791. During the illness which terminated his life, Mirabeau confided himself entirely to the professional skill of Cabanis. Of the progress of the malady, and the circumstances attending the death of Mirabeau, Cabanis drew up a very detailed narrative, which is not calculated, however, to impress us with any high idea of his skill in the treatment of an acute inflammatory disease. Condorcet was another distinguished character with whom Cabanis was intimate, and whom he endeavoured, though without success, to save from the destiny in which he afterwards became involved by the calamitous events of the Revolution. Shortly after this he married Charlotte Grouchy, sister to Madame Condorcet and to General Grouchy,—a union which was a great source of happiness to him during the remainder of his life.

After the subversion of the Government of the terrorists, Cabanis, on the establishment of central schools, was named professor of *Hygiène* in the medical schools of the metropolis. Next year he was chosen member of the National Institute, and was subsequently appointed clinical professor. He was afterwards member of the Council of Five Hundred, and then of the Conservative Senate. The dissolution of the Directory was the result of a motion which he made to that effect. But his political career was not of long continuance. A foe to tyranny in every shape, he was decidedly hostile to the policy of Bonaparte, and constantly rejected every solicitation to accept a place under his Government.

For some years before his death his health became gradually more impaired, and he retired from the laborious duties of his profession, spending the greatest part of his time at the chateau of his father-in-law at Meulan. Here he solaced himself with reading his favourite poets, and even had it in contemplation to resume that translation of the *Iliad* which had been the first effort of his youthful muse. The rest of his time was devoted to acts of kindness and beneficence, especially towards the poor, who flocked from all parts to consult him on their complaints. Cabanis died May 5 1808, leaving a widow and a daughter.

A complete edition of Cabanis's works was begun in 1825, and five volumes were published. One of his minor works, *Coup d'œil sur les révolutions et les réformes de la médecin*, has been translated into English. His principal work, *Rapports du physique et du moral de l'homme*, consists in part of memoirs, read in 1796 and 1797 to the Institute, and printed among their Transactions. It is an admirable sketch of physiological psychology, and is replete with information. Psychology is with Cabanis directly linked on to biology, for sensibility, the fundamental fact, is the highest grade of life and the lowest of intelligence. All the intellectual processes are evolved from sensibility, and sensibility itself is a property of the nervous system. The soul is not an entity, but a faculty; thought is the function of the brain. Just as the stomach and intestines receive food and digest it, so the brain receives impressions, digests them, and has as its organic secretion, thought. Alongside of this harsh materialism Cabanis held another principle, the application of which altogether changes his theory. He belonged in biology to the school of Stahl, the vitalist or animist, and in the posthumous work, *Lettre sur les causes premières*, the consequences of this opinion became clear. Life is something added to the organism; over and above the universally diffused sensibility there is some living and productive power to which we give the name of Nature. But it is impossible to avoid ascribing to this power both intelligence and will. In us this living power constitutes the ego, which is truly immaterial and immortal. These results Cabanis did not think out of harmony with his earlier theory, and it is possible that a point of view may be attained whence both appear justified. The *Lettre* was not published till 1824, when it appeared with notes by F. Bérard.

CABARRUS, François (1752-1810), conspicuous in Spanish history as a financier, was born at Bayonne, where his father was a merchant. Being sent into Spain on business he fell in love with a Spanish lady, and marrying her, settled in Madrid. Here his private business was the manufacture of soap; but he soon began to interest himself in the public questions which were ventilated even at the court of Spain. The enlightenment of the 18th century had penetrated as far as Madrid; the king, Charles III., was favourable to reform; and a circle of men animated by the new spirit were trying to infuse fresh vigour into an enfeebled state. Among these Cabarrus became conspicuous, especially in finance. He originated a bank, and a company to trade with the Philippine Islands; and as one of the council of finance he had planned many reforms in that department of the administration, when Charles III. died (1788), and the reactionary Government of Charles IV. arrested every kind of enlightened progress. The men who had taken an active part in reform were suspected and prosecuted. Cabarrus himself was accused of embezzlement, and thrown into prison. After a confinement of two years he was released, created a count, and employed in many honourable missions; he would even have been sent to Paris as Spanish ambassador, had not the Directory objected to him as being of French birth. Cabarrus took no part in the transactions by which Charles IV. was obliged to abdicate and make way for Joseph, brother of Napoleon, but his French birth, and intimate knowledge of Spanish affairs recommended him to the Emperor as the fittest person for the difficult post of minister of finance. In this capacity Cabarrus died (1810). His beautiful daughter Thérése, under the name of Madame Tallien (afterwards Princess of Chimay), played an interesting part in the later stages of the French Revolution.

CABATUAN, a town of the Philippine Islands, in the province of Iloilo, in Panay, situated on the banks of the River Tiguin, which changes from an almost empty channel to an impetuous torrent, so that navigation is frequently impossible. The town, which was founded in 1732, has about 23,000 inhabitants, who are principally engaged in the cultivation of rice and the manufacture of cocoa-nut oil. See Bowring's *Philippine Islands*.

CABAZERA, a town of the Philippine Islands, capital of the province of Cagayan in Luzon, with a population of about 15,000. Tobacco-growing is the most important occupation of the district.

CABBAGE. The parent form of the variety of useful culinary vegetables included under this head is generally supposed to be the wild or sea cabbage (*Brassica oleracea*), a plant found near the sea coast of various parts of England and continental Europe, although Alph. de Candolle considers it to be really descended from the two or three allied species which are yet found growing wild on the Mediterranean coast. In any case the cultivated varieties have departed very widely from the original type, and they present very marked and striking dissimilarities among themselves. The wild cabbage is a comparatively insignificant plant, growing from 1 to 2 feet high, in appearance very similar to the corn mustard or charlock (*Sinapis arvensis*), but differing from it in having smooth leaves. The wild plant has fleshy, shining, waved, and lobed leaves (the uppermost being undivided but toothed), large yellow flowers, elongated seed-pod, and seeds with conduplicate cotyledons. Notwithstanding the fact that the cultivated forms differ in habit so widely, it is remarkable that the flower, seed-pods, and seeds of the varieties present no appreciable difference.

The late Dr Lindley proposed the following classification for the various forms, which includes all yet cultivated:—1. All the leaf-buds active and open, as in wild cabbage and kale or greens; 2. All the leaf-buds active, but forming heads, as in Brussels sprouts; 3. Terminal leaf-buds alone active, forming a head, as in common cabbage, savoys, &c.; 4. Terminal leaf-bud alone active and open, with most of the flowers abortive and succulent, as in cauliflower and broccoli; 5. All the leaf-buds active and open, with most of the flowers abortive and succulent, as in sprouting broccoli. The least variety bears the same relation to common broccoli as Brussels sprouts do to the common cabbage. Of all these forms there are numerous gardeners' varieties, all of which reproduce faithfully enough their parent form by proper and separate cultivation. Under Dr Lindley's first class, common or Scotch kale is a variety which formerly was in extensive cultivation, and is still found in the cottage "kail-yards" or gardens of the Scottish peasantry. It sends up a stout central stem, growing upright to a height of about 2 feet, with close-set, large thick plain leaves of a light red or purplish hue. The lower leaves are stripped off for use as the plants grow up, and used for the preparation of broth or "Scotch kail," a dish at one time in great repute in the north-eastern

districts of Scotland. Tall or German greens, which grow to the height of 4 feet, with bright green very much curled leaves, have largely superseded kale in cultivation. A very remarkable variety of open-leaved cabbage is cultivated in the Channel Islands under the name of the Jersey or branching cabbage. It grows to a height of 8 feet, but has been known to attain double that altitude. It throws out branches from the central stem, which is sufficiently firm and woody to be fashioned into walking-sticks; and the stems are even used by the islanders as rafters for bearing the thatch on their cottage-roofs. Several varieties are cultivated as ornamental plants on account of their beautifully coloured, frizzled, and laciniated leaves. Brussels sprouts, which represent Dr Lindley's second class, are miniature cabbage-heads, about an inch in diameter, which form in the axils of the leaves. They form a tender and delicate table vegetable. The third class is chiefly represented by the common or drumhead cabbage, the varieties of which are distinguished by difference in size, form, and colour. In Germany it is converted into a popular article of diet under the name of *Sauerkraut* by placing in a tub alternate layers of salt and cabbage. An acid fermentation sets in, which after a few days is complete, when the vessel is tightly covered over and the product kept for use with animal food. Cabbages contain a large percentage of nitrogenous compounds as compared with most other articles of food. Their percentage composition is—water, 93·4; albumen, 1·8; starch and dextrin, 3·3; woody fibre, 0·5; and mineral ash, 0·8. Red cabbage is chiefly used for pickling, and the Savoy is a hardy green variety, characterized by its very wrinkled leaves. The Portugal cabbage, or *Couve Tronchuda*, is a variety, the tops of which form an excellent cabbage, while the midribs of the large leaves are cooked like sea-kale. Cauliflower, which is the chief representative of class four, consists of the inflorescence of the plant modified so as to form a compact succulent white mass or head; this is upon the whole the most highly prized cultivated form of the plant, and has been in use from very remote times. Broccoli is merely a variety of cauliflower differing from the other in the form and colour of its inflorescence and its hardiness. Broccoli sprouts, the representative of the fifth class, is a form of recent introduction, and consists of flowering sprouts springing from the axils of the leaves. Kohl-rabi is a peculiar and exceptional variety of cabbage in which the stem, just above ground, swells into a fleshy turnip-like mass. It is much cultivated in certain districts as a food for cattle. The varieties of cabbage, like many other Cruciferous plants, are possessed of anti-scorbutic properties; but unless eaten when very fresh and tender they are difficult of digestion, and have a very decided tendency to produce flatulence.

Several species of palm, from the fact of yielding large sapid central buds which are cooked as vegetables, are known as Cabbage Palms. The principal of these is *Areca oleracea*, but other species, such as the Coco Palm, the *Maximiliana regia*, *Arenga saccharifera*, &c., yield similar edible leaf-buds.

CABBALA AND CABBALISTS. See KABBALA.

CABENDA, or CABINDA, a seaport town of Western Africa, in Lower Guinea, 40 miles north of the mouth of the Zaire, on the right bank of the Bele, in 5° 33′ S. lat., 15° 40′ E. long. From the great beauty of its situation, and the fertility of the adjacent country, it has been called the paradise of the coast. The harbour is well sheltered and commodious, and the trade is considerable. Population about 16,000.

CABET, ÉTIENNE (1788–1856), an active French Communist, was born, the son of a cooper, at Dijon in 1788. He chose the profession of advocate without succeeding in it, but erelong became notable as the persevering apostle of republicanism and communism. He assisted in a secondary way in the Revolution of 1830, and obtained a legal appointment in Corsica under the Government of Louis Philippe; but, being dissatisfied with the moderation of the new rule, he began to attack it even in public, and was dismissed. Elected, notwithstanding, to the Chamber of Deputies, he was prosecuted for his bitter criticism of the Government, and obliged to go into exile in England. On the amnesty of 1839, he returned to France, and attracted some notice by the publication of a badly-written and fiercely democratic history of the Revolution of 1789 (4 vols., 1840), and of a social romance, *Voyage en Icarie*, in which he set forth his peculiar views. These works met with some success among the radical working-men of Paris. An opportunity at length occurred of realizing his schemes. Pressed by his friends, he made arrangements for an experiment in communism on American soil. In his journal, *Le Populaire*, he announced the purchase of a considerable tract of land on the Red River, Texas, and a treaty by which Cabet was made the dictator of an intending colony, and the depositary of all the funds, community of property being the distinctive principle of the society. Accordingly, in 1848, an expedition of 150 sailed to America; but unexpected difficulties arose and the complaints of the disenchanted settlers soon reached Europe. Cabet, who had remained in France, had more than one judicial investigation to undergo in consequence, but was honourably acquitted. In 1849 he went out in person to America, but on his arrival, finding that the Mormons had been expelled from their city Nauvoo, in Illinois, he transferred his settlement thither. There, with the exception of a journey to France, where he returned to defend himself successfully before the tribunals, he remained, the dictator of his little society. In 1856, however, he was expelled, and died the same year at St Louis. He had not the advantages of either birth or eloquence, or even of ability. The little success he obtained was due entirely to the singularity of his opinions, and the straightforward persistency with which he advocated them.

CABEZA DEL BUEY (*i.e.*, bullock's head), a town of Spain, in Estremadura, in the province of Badajoz, and 86 miles E.S.E. from the city of that name. It manufactures woollen cloth, and has a population of 6500.

CABINET, a conventional, but not a legal, term employed to describe those members of the Privy Council who fill the highest executive offices in the State, and who, by their concerted policy, direct the Government, and are responsible for all the acts of the Crown. The Cabinet now always includes the persons filling the following offices, who are therefore called Cabinet Ministers, viz:—The First Lord of the Treasury; the Lord Chancellor, the Lord President of the Council, the Lord Privy Seal, the five Secretaries of State, the Chancellor of the Exchequer, and the First Lord of the Admiralty. The Chancellor of the Duchy of Lancaster, the Postmaster General, the First Commissioner of Works, the President of the Board of Trade, the Chief Secretary for Ireland, the President of the Poor Law Board, and the Vice-President of the Education Committee are sometimes members of the Cabinet, but not necessarily so. Hence the Cabinet must consist of at least eleven members, and it has sometimes included as many as seventeen. But the better opinion appears to be that a large Cabinet is an evil. Mr Disraeli in 1874 acted wisely in restricting the numbers of his colleagues to eleven besides the Prime Minister. When Lord Grenville in 1806 brought Lord Chief Justice Ellenborough into the Cabinet by combining his judicial office with that of Lord President, the appointment was strongly reprobated, and the experiment has never been repeated. The Master-General of the

Ordnance used to have a seat in the Cabinet, and the duke of Wellington sat there for a short time as Commander-in-Chief. Of late years there has been no military officer in the Cabinet, a thing much to be regretted. In a few instances privy councillors of very high standing, as the duke of Wellington, Lord Sidmouth the marquis of Lansdowne, and Lord Russell, have been summoned to the Cabinet without office. There is no constitutional objection to summoning any privy councillor to the Cabinet by command of the sovereign.

The word "Cabinet," or "Cabinet Council," was originally employed as a term of reproach. Thus Lord Bacon says, in his essay *Of Counsel* (xx.), "The doctrine of Italy and practice of France, in some kings' times, hath introduced Cabinet Councils—a remedy worse than the disease;" and, again, "As for Cabinet Councils, it may be their motto *Plenus rimarum sum*." Lord Clarendon—after stating that, in 1640, when the great Council of Peers was convened by the king at York, the burden of affairs rested principally on Laud, Strafford, and Cottington, with five or six others added to them on account of their official position and ability—adds, "These persons made up the Committee of State, which was reproachfully after called the *Juncto*, and enviously then in Court the *Cabinet Council*." And in the Second Remonstrance in January 1642, Parliament complained "of the managing of the great affairs of the realm in *Cabinet Councils*, by men unknown and not publicly trusted." But this use of the term, though historically curious, has in truth nothing in common with the modern application of it. It meant, at that time, the employment of a select body of favourites by the king, who were supposed to possess a larger share of his confidence than the Privy Council at large.[1] Under the Tudors, at least from the later years of Henry VIII., and under the Stuarts, the Privy Council was the Council of State or Government. During the Common-wealth it assumed that name.

The Cabinet Council, properly so called, dates from the reign of William III. and from the year 1693, for it was not until some years after the Revolution that the king discovered and adopted the two fundamental principles of a constitutional Executive Government, namely, that a ministry should consist of statesmen holding the same political principles and identified with each other; and, secondly, that the ministry should stand upon a parliamentary basis, that is, that it must command and retain the majority of votes in the Legislature. It was long before these principles were thoroughly worked out and understood, and the perfection to which they have been brought in modern times is the result of time, experience, and, in part, of accident. But the result is that the Cabinet Council for the time being *is* the Government of Great Britain; that all the powers vested in the sovereign (with one or two exceptions) are practically exercised by the members of this body; that all the members of the Cabinet are jointly and severally responsible for all its measures, for if differences of opinion arise their existence is unknown as long as the Cabinet lasts,—when publicly manifested the Cabinet is at an end; and lastly, that the Cabinet, being responsible to the sovereign for the conduct of executive business, is also collectively responsible to Parliament both for its executive conduct and for its legislative measures, the same men being as members of the Cabinet the servants of the Crown, and as Members of Parliament and leaders of the majority responsible to those who support them by their votes and may challenge in debate every one of their actions. In this latter sense the Cabinet has sometimes been described as a Standing Committee of both Houses of Parliament.

This in reality is the form to which the active governing machinery of the British Constitution has now been brought. It has been ingeniously argued by Mr Bagehot, in his *Essays on the Constitution*, that "the Cabinet is a board of control, chosen by the Legislature, out of the persons whom it trusts and knows, to rule the nation," and that the choice of the Crown and of the Prime Minister, who frames the list of Cabinet Ministers to be laid before the sovereign, is in fact circumscribed and predetermined by the position which a small number of men in each party have acquired in Parliament. No man can long remain a Cabinet Minister who is not in Parliament; and of those who sit in either House of Parliament, but a small proportion have attained to the rank or influence that fits a man to be a Cabinet Minister. This is especially the case in the House of Commons, largely composed of men engaged in various professions; for it is easier to find men of high senatorial rank and experience in the House of Peers than in the other House, because in England members of the Peerage are frequently trained and educated from early life for high office and the public service. The Cabinet, therefore, really originates in the Legislature, though its functions are the functions of executive government, and although it disposes on behalf of the Crown of a vast amount of power, patronage, honours, &c., to which the authority of the Legislature does not extend. The Cabinet has, moreover, one most important power, which it derives entirely from the Crown, namely, that of dissolving the Legislature to which it owes its own existence—though this is in fact no more than an appeal to the nation at large, whose representative the Legislature is. The power of dissolving Parliament is one usually, though not always unreservedly, entrusted by the sovereign to the Prime Minister; but if withheld when solicited, the minister would resign.

Instances are not wanting in our history in which the direct action of the sovereign has overthrown a Cabinet, or prevented a Cabinet from being formed. In 1784 George III. dismissed the Coalition Ministry. In 1807 the king also dismissed Lord Grenville's Cabinet, in the teeth of Lord Erskine's declaration of the high Whig doctrine, that the king had handed over every power of government, and even his own conscience, to his responsible advisers. In these instances the Crown succeeded, and the new Parliament ratified the change. Not so in 1834 when William IV. dismissed Lord Melbourne's Cabinet, placed the duke of Wellington for some weeks in sole possession of all the Cabinet offices, and called Sir Robert Peel to power. In 1812 Lord Moira was defeated in the attempt to form a Cabinet by the refusal of the regent to consent to a change in the household; and in 1839 a similar reason was alleged by Queen Victoria to prevent the accession to office of Sir Robert Peel. But though this step was defended and sanctioned by a minute of the Whig Cabinet of the day, it is now generally regarded as unconstitutional, and the objection was never repeated.

One of the consequences of the close connection of the Cabinet with the Legislature is that it is desirable to divide the strength of the ministry between the two Houses of Parliament. Mr Pitt's Cabinet of 1783 consisted of himself in the House of Commons and seven peers. But so aristocratic a Government would now be impracticable. In Mr Gladstone's large Cabinet of 1868, eight, and afterwards nine, ministers were in the House of Commons and six in the House of Peers. Great efforts were made to strengthen

[1] Thus, under Charles II., in 1671, the king's confidential advisers were Clifford, Arlington, Buckingham, Ashley, and Lauderdale. The initial letters of their names spell the word "Cabal;" and Lord Macaulay affirms that the word cabal was popularly used as synonymous with cabinet. But the word cabal certainly never was applied to any other cabinet: and the cabal itself was not in truth a cabinet at all.

the ministerial bench in the Commons, and a new principle was introduced, that the representatives of what are called the spending departments—that is, the Secretary of State for War and the First Lord of the Admiralty—should, if possible, be members of the House which votes the supplies. Mr Disraeli followed this precedent.

Although the Government of this country is one of extreme publicity, it is to the credit of the good sense and good faith of Englishmen that the deliberations and proceedings of the Executive Government are veiled in impenetrable secrecy, until the moment when the result of them is made known. Beyond the meagre announcement in the *Court Circular* of the bare fact that a Cabinet has been held, and that certain ministers were present, nothing is communicated to the public. Cabinets are usually convoked by a summons addressed to "Her Majesty's Confidential Servants," by direction of the Prime Minister; and the ordinary place of meeting is the Foreign Office, but they may be held anywhere. No secretary or other officer is present at the deliberations of this council. No official record is kept of its proceedings, and it is even considered a breach of ministerial confidence to keep a private record of what passed in the Cabinet, inasmuch as such memoranda may fall into other hands. But on some important occasions, as is known from the *Memoirs of Lord Sidmouth*, the *Correspondence of Earl Grey with King William IV.*, and from Sir Robert Peel's *Memoirs*, published by permission of the Queen, Cabinet minutes are drawn up and submitted to the sovereign, as the most formal manner in which the advice of the ministry can be tendered to the Crown and placed upon record. More commonly, it is the duty of the Prime Minister to lay the collective opinion of his colleagues before the sovereign, and take his or her pleasure on public measures and appointments. The sovereign never presides at a Cabinet, and at the meetings of the Privy Council, where the sovereign does preside, the business is purely formal. It has been laid down by some writers as a principle of the British Constitution that the sovereign is never present at a discussion between the advisers of the Crown; and this is, no doubt, an established fact and practice. But like many other political usages of this country it originated in a happy accident. King William and Queen Anne always presided at weekly Cabinet Councils. But when the Hanoverian princes ascended the throne, they knew no English, and were barely able to converse at all with their ministers; for George I. or George II. to take part in, or even to listen to, a debate in council was impossible. When George III. mounted the throne the practice of the independent deliberations of the Cabinet was well established, and it has never been departed from. In no other country has this practice been introduced, and perhaps this is one reason why in many instances constitutional government has failed to take root.

Differences of opinion, of course, occur in all bodies of men, and arguments are frequently presented with greater ability and temper in private than in public debate. These differences are decided in the Cabinet, as in all committees of council, by the majority of votes, and the rule holds good in all of them that "no man shall make publication of how the minority voted." The vote once taken and the question decided, every member of the Cabinet becomes equally responsible for the decision, and is equally bound to support and defend it. A decided difference of opinion cannot be persisted in or publicly expressed without withdrawing from the Cabinet, as when Mr Gladstone quitted Sir Robert Peel's administration upon the proposal to endow Maynooth. Hence it arises that resignations, or threats of resignation, are much more common than the public imagine; and a good deal of tact and management is continually exercised in reconciling these differences. A serious "division in the Cabinet" is, as is well known, an infallible sign of its approaching dissolution. There are cases in which a minister has been dismissed for a departure from the concerted action of his colleagues. Thus, in 1851, Lord Palmerston having expressed to the French ambassador in London his unqualified approbation of the *coup d'état* of Louis Napoleon against the Assembly, when the Cabinet had resolved on observing a strict neutrality on the subject, Lord Russell advised Her Majesty to withdraw from Lord Palmerston the seals of the Foreign Department, and his lordship never again filled that office.

A clause was introduced into the Act of Settlement of 1705 requiring all Acts of State to be transacted in the Privy Council and signed by all the members present. This provision was found to be inconvenient, and was repealed two years afterwards. According to modern usage only one kind of public document is signed by all the members of the Cabinet, as privy councillors, and that is the order for general reprisals which constitutes a declaration of war. Such an order was issued against Russia in 1854, and was signed by all the members of Lord Aberdeen's Cabinet.

Upon the resignation or dissolution of a ministry, the sovereign exercises the undoubted prerogative of selecting the person who may be thought by the Court most fit to form a new Cabinet. In several instances the statesmen selected by the Crown have found themselves unable to accomplish the task confided to them. But in more favourable cases the minister chosen for this supreme office by the Crown has the power of distributing all the political offices of the Government as may seem best to himself, subject only to the ultimate approval of the sovereign. The First Minister is therefore in reality the author and constructor of the Cabinet; he holds it together; and in the event of his retirement, from whatever cause, the Cabinet is really dissolved, even though its members are again united under another head, as was the case when Lord Melbourne succeeded Lord Grey in 1834, and when Mr Disraeli succeeded Lord Derby in February 1868. Each member of the Cabinet, in fact, holds office under the First Lord of the Treasury, and in the event of resignation it is to him that the announcement of such an intention should be made.

The best account of the Cabinet council and of the other executive machinery of the constitution is to be found in Mr Alpheus Todd's *Essay on Parliamentary Government in England* (2 vols. 8vo, 1867-69), where all the authorities are collected—Hallam, May, John Austin, Lord Macaulay—and a vast quantity of political information, compiled from debates and bearing on this subject. Mr Bagehot's *Essay on the English Constitution* contains an ingenious comparison, or rather contrast, between the British Cabinet and the administrative mechanism of the United States of America. (H. R.)

CABIRI (Κάβειροι), in Mythology, usually identified with the Dioscuri (Castor and Pollux), in common with whom they were styled *μεγάλοι Θεοί* (*magni Dii*), and had the power of protecting life against storms at sea, the symbol of their presence being the St Elmo fire. The worship of the Cabiri was local and peculiar to the islands of *Lemnos*, Imbros, and Samothrace, extending also to the neighbouring coast of Troy, in which places it appears to have been inherited from a primitive Pelasgic population. It was, however, in Samothrace that this worship attained its chief importance, coming first into notice apparently after the Persian war, and from that time extending its influence down into the Roman period. The point of attraction was in the religious Mysteries, initiation into which was sought for, not only by large numbers of pilgrims, but also by such persons of distinction as Philip and Olympias—the parents of Alexander, his successor Lysimachus, Arsinoë, and those Roman commanders whose duties led them to that quarter.

What the rites were in which the Mysteries consisted is unknown, and it is therefore impossible to say how far they may have been organized on the model of the Mysteries of Eleusis, though it is clear that Athens took a considerable part in being the first to extend the influence of the Samothracian Mysteries. Initiation included also an asylum or refuge, if required, within the strong walls of Samothrace, for which purpose it was used among others by Arsinoë, who afterwards caused to be erected there (276–247 B.C.), to record her gratitude, a monument, the ruins of which were explored in 1874 by an Austrian archæological expedition (*Untersuchungen auf Samothrake*, by Conze, Hauser, and Niemann, Vienna, 1875).

In Lemnos an annual festival was held, lasting nine days, during which all the fires in the island were extinguished and fresh fire brought from Delos. From this and from the statement of Strabo (x. 437), that the father of the Cabiri was Camillus, a son of the god Hephæstus, it has been thought that the Cabiri must have been, like the Curetes, Corybantes, and Dactyls, dæmons of volcanic fire. But this is very uncertain. In Lemnos they fostered the growth of the vine and fruits of the field, and from their connection with Hermes in Samothrace, it would seem that they had also aided the fertility of cattle. Both the names and the number of the Cabiri are doubtful. On late authority they are given as *Axieros*, *Axiokersa*, and *Axiokersos*, with a fourth called *Kadmilos* or *Kasmilos*; but in the usual tradition they were *Dardanos*, *Jasion*, and *Harmonia*. Jasion, who was a favourite of the goddess Demeter, instituted the Mysteries. Harmonia married Cadmus of Thebes, whose name is to be recognized in Kadmilos, one of the Cabiri. On the other hand it has been argued that there were only two Cabiri, Dardanus and Jasion, corresponding as deities to the Greek Poseidon and Apollo, or Uranus and Gæa, *i.e.*, sky and earth. On these points, the statements of ancient writers are not only few but generally irreconcilable with each other. On Etruscan bronze mirrors representations of what are called the Cabiri frequently occur, consisting of two youthful figures, sometimes with the addition of a female figure, apparently their sister; sometimes there are three brothers. This subject is dealt with in detail by Gerhard in his *Etruskische Metall-Spiegel*.

CABLE, a rope or chain used for connecting a ship with her anchor. Chain cables are generally used, but on account of their weight they are unsuitable for mooring in very deep water, when several lengths of cable would be hanging at the "hawse pipe;" and they cannot be used, also on account of their weight, when it is required to lay an anchor out at some distance from the ship. Hempen cables are, therefore, supplied to all ships as well as chain cables. For sizes, number, and lengths of cables carried by ships of the Royal Navy and required by Lloyd's rules to be supplied to merchant ships, see article ANCHOR.

The length of a chain cable is 100 fathoms, and that of a hempen cable 101 fathoms. The term "a cable's length," by which the distance of vessels from each other is usually given in nautical parlance, is understood to mean 100 fathoms, or 200 yards. Cables are sometimes made of common chain, but the best and most approved are made of stud-link chain, as shown in fig. 1, which gives the relative proportions of the various parts. Cables are made in lengths of 12½ fathoms, connected together by "joining shackles," as shown at D. Each length is "marked" by a piece of iron-wire being twisted round the stud of one of the links, the wire being placed on the first stud inside the first shackle,—*i.e.*, the stud nearest to the shackle on the side remote from the anchor,—on the second stud inside the second shackle, and so on, so that the length of cable which is out may always be known. For instance, if the mark is on the sixth stud inside the first inboard shackle, it is known that six lengths, or 75 fathoms, of cable are out, measuring from that shackle. In joining the lengths together the round end of the shackle should be placed towards the anchor. The end links of each length C, C are made without studs in order to receive the shackles, and it is necessary to make them of iron of greater diameter than that used for the stud links, in order to keep them of equal strength. The stud keeps the link from collapsing, and increases its strength considerably.

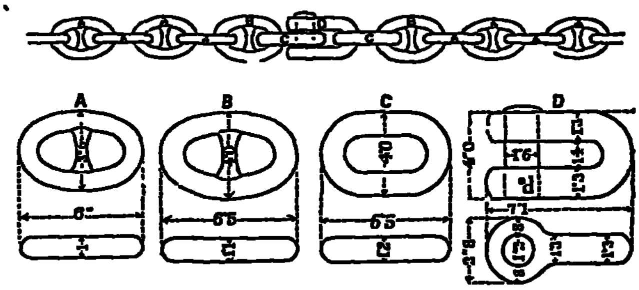


FIG. 1.—Stud-link Chain.[1]

The next links B, B in their turn have to be enlarged to enable them to take the increased size given to the links C, C. It will be observed from the sketch of the shackle D that the pin is made oval, its greater diameter being in the direction of the strain. The pin of the shackle which attaches the cable to the anchor, and is called the "anchor shackle" in distinction from the "joining shackles," may project and be secured by a forelock; but as any projection would be detrimental when the chain is running out (sometimes with great rapidity) through the hawse pipes, the pins of the joining shackles are made as shown, and are secured by a small pin *d*. This small pin is kept from coming out by being made a little short, so that a lead pellet may be driven in at either end to fill up the holes in the shackle, which are made with a groove, so that as the pellets are driven in they expand or dovetail, and thus keep the small pin secure in its place.

The cables are stowed in the chain lockers, the inner ends being firmly secured to the ship by a "slip." This is done to render it impossible for the cable to run out and be lost accidentally, the slip being provided so that the cable may be let go without difficulty if stress of weather or any other cause renders such a proceeding imperative. It is necessary to fit one or two swivels in each cable to avoid turns being taken in it as the ship swings. When a ship is moored with two anchors the cables are attached to a mooring swivel (fig. 2); if this is not done the cables get entwined around each other, forming what is termed a "foul hawse," which is a troublesome thing to clear.

The cable is hove up in large vessels by a capstan, and in small ones by a windlass. It is brought directly to the capstan, the inner end passing to the deck pipe, and thence to the chain lockers; or it is brought in by means of a messenger, which is an endless chain passing round the capstan and a roller on each side of the deck near the hawse pipes. The cable is stoppered to the messenger by rope or iron nippers, and as the messenger goes round with the capstan the cable is brought in, the nippers being shifted as required. Messengers are now almost entirely superseded by the improved make of capstans.

Various means for checking the cable as it is running out, and for holding it, have been devised. The old-

[1] The dimensions marked in the figure are those for one-inch chains and signify so many diameters of the iron of the common links,—these forming a scale for all sizes.

fashioned plan is to fit a strong iron lever called a "compresser" under the deck pipe, fixed at one end in such a position that when the other end is hove round by a tackle the cable will be jammed between the compresser and the lower edge of the pipe. In place of compressers, or to act in conjunction with them, several kinds of stoppers have been used, fitted either at the deck pipes, or just inside the hawse pipes; those patented by Harfield and Co. find the most favour in the Royal Navy, but the compressers are

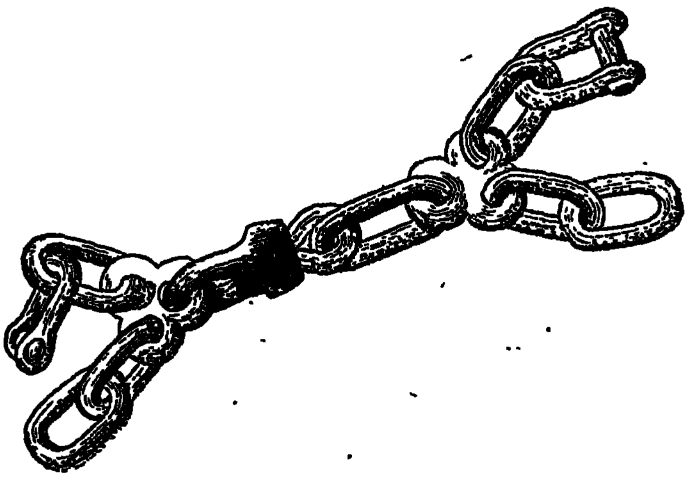


FIG. 2.—Mooring Swivel.

almost invariably fitted with them. Ships are generally held when "riding at anchor" by one or two turns of the cable being taken round the "riding bitts," which are strong structures of iron or wood, placed for this purpose near the hawse pipes. "Stopper bolts"—*i.e.*, ring-and-eye bolts, placed in the deck forward—are also fitted, to which the cable may be secured while the turns are being put on or taken off the riding bitt, while the mooring swivel is being attached, or at other times. (T. M.)

CABOT, SEBASTIAN,[1] the renowned navigator, and contemporary of Columbus, was the son of John Cabot, a Venetian merchant, and was born in Bristol, England, while his father was a resident of that city. On the disputed question of his birthplace, Richard Eden (*Decades of the New World*, fol. 255) says Sebastian told him that, when four years old, he was taken by his father to Venice, and returned to England while still very young, "whereby he was thought to have been born in Venice." Stow, in his *Annals*, under the year 1498, styles "Sebastian Gaboto a Genoas sonne, borne in Bristow." Galvano and Herrera also give to England the honour of his nativity. Neither the year of his birth nor that of his death can be stated with precision; conjecture fixes the former event in about 1476. No instructive details of his early life, until he had passed his twentieth year, can now be recovered.

The discoveries of Columbus infused into young Sebastian an ardent desire to emulate his brilliant achievements. Henry VII. resolved to enter the new field of maritime discovery, which had already rewarded Spain with the Antilles; and the Cabots having proposed to the king the project of shortening the voyage to India by sailing west, to them was confided its execution.

The first patent was granted March 5, 1496 (11th Henry VII.), to "John Gabote, citizen of Venice; to Lewes, Sebastian, and Santius, sonnes of the said John." It empowered them to seek out, subdue, and occupy, at their own charges, any regions which before had "been unknown to all Christians." They were authorized to set up the royal banner, and possess the territories discovered by them as the king's vassals. Bristol was the only port to which they were permitted to return; and a fifth part of the gains of the voyage was reserved to the Crown. The discoverers were vested with exclusive privilege of resort and traffic.

With respect to Lewes and Santius, the chronicles are silent. John and Sebastian sailed from Bristol in the "Matthew" in the following year (1497), and, as now seems probable, returned to England after the first discovery had been made (see BRISTOL, p. 350). There is in the account of the Privy Purse expenses of Henry VII. the following entry:—"10th August 1497. To him that found the New Isle, £10."

Although it is probable that the Island of Newfoundland was discovered in this voyage, a careful scrutiny of the various maps and chronicles sustains the belief that the Cabots saw the mainland of America before any other,—the term *Terra primum visa* having been used to distinguish the continent, or what was believed to form a part of it. The relation of Sebastian (see Hakluyt, 111, p. 7) does not warrant the inference that the first land seen was an island.

The most precise account of the discovery is from a map drawn by Sebastian Cabot, and engraved in 1549 by Clement Adams, which is known to have hung in Queen Elizabeth's gallery at Whitehall. The notice runs as follows:—"In the year of our Lord 1497, John Cabot, a Venetian, and his son Sebastian, discovered that country which no one before his time had ventured to approach, on the 24th of June, about five o'clock in the morning. He called the land *Terra primum visa*, because, as I conjecture, this was the place that first met his eye in looking from the sea. On the contrary, the island which lies opposite the land he called the island of St John,—as I suppose, because it was discovered on the festival of St John the Baptist."

On Sebastian Cabot's map of 1544, the original of which is in the Geographical Cabinet of the Imperial Library at Paris (see fac-simile in Jomard's *Monuments de la Géographie*), nothing is designated above the sixtieth parallel. *Prima tierra vista* is delineated between 45° and 50°, with the island St Juan (corresponding with Prince Edward), within the great gulf at the embouchure of what is plainly the St Lawrence. The authenticity of the map being accepted, the "land first seen" could be no other than the coast of Nova Scotia, or island of Cape Breton.

A second "patent" to John Cabot, dated 3d February 1498, authorized him to take six English ships, of not more than 200 tons, in any port in the realm, "and them convey and lede *to the lande and isles* of late found by the said John in oure name and by oure commandment." Before the expedition was ready, John Cabot died, and Sebastian, with a fleet of five vessels, sailed from Bristol in May 1498. It is believed that this is the voyage referred to by Peter Martyr, Gomara, Fabyan, and by Sebastian himself in his letter to Ramusio. Cabot, upon falling in with the coast, ascended it as high as latitude $67\frac{1}{2}°$, probably passing into Hudson's Bay. He persevered in the effort to find an open channel to India, *until* his sailors, appalled by the danger of navigating the ship among icebergs, broke out in open mutiny and compelled him to turn back. He then retraced his course, pausing at Baccalaos to refit; and, after examining the coast as far south as 38°, returned to England. Sebastian took with him in this voyage three hundred men, with the purpose, as Gomara states, of colonizing the newly-found regions. Thevet, French cosmographer, relates that Cabot landed these emigrants where the cold was so intense that nearly the whole company perished, although it was in July. Cabot brought to England three native inhabitants of the countries he had visited; his great achievement was the discovery of eighteen hundred miles of sea-coast of the North American continent.

[1] Gabote, Patent of 1496; Kabotto, Patent of 1498; Cabote, Eden; Gaboto, Gomara.—*Stow*.

Except the vague report of a voyage undertaken by him in 1499, nothing more appears relative to Sebastian until 1512, when he is found living at Seville, engaged in revising the Spanish king's maps and charts. The death of Ferdinand put an end to a design to renew the search for a north-west passage to Cathay, and Cabot, who was to have commanded, returned to England. In 1517 he undertook, with Sir Thomas Perte, another voyage,—whether of discovery or conquest in Spanish America is uncertain. In 1518 Sebastian revisited Spain, and was appointed pilot-major. After the conference of Badajos, a squadron was fitted out under Cabot to pursue Spanish discovery in the Pacific. It set sail in August 1526, but some of his chief officers having spread disaffection in the fleet, Cabot abandoned the original plan as impracticable, and put into the La Plata. He sailed up this river 350 leagues, built a fort at one of the mouths of the Parana, which stream he ascended in boats, and also penetrated some distance up the Paraguay. Failing to obtain the aid he solicited, and weakened by the assaults of the natives, Sebastian was forced to leave the coast for Spain.

He now, for the second time, returned to England, and notwithstanding a demand by the emperor that "he might be sent over to Spain," settled at Bristol. Edward VI., in 1549, granted the now aged seaman a pension of two hundred and fifty marks. Hakluyt states that the office of Grand Pilot of England was created for him. It was at this period that he explained to the king the phenomenon of the variation of the needle. He was active in promoting the expedition of 1553 to Russia, the success of which gave him the life appointment of Governor of the Muscovy Company.

Cabot is supposed to have died in London, in 1557, sixty-one years subsequent to the date of his first commission from Henry VII., and not far from eighty years old. The place of his burial is unknown, and we are indebted to Eden for the death-bed scene of this intrepid navigator, who saw the American continent before Columbus or Amerigo Vespucci. His character is extolled by contemporaries, and was distinguished for lofty courage and unflagging perseverance in the execution of his designs. Few lives exhibit such incessant activity in the pursuit of an idea. The maps and discourses drawn and written by himself would, if in existence, have shed much light on an illustrious career; but, with the exception of a map said to have been recovered in Germany, and another existing in France, no trace of them remains. The memoir by Richard Biddle, London and Philadelphia, 1831, though faulty in arrangement, is still the best.

CABRA, a town of Spain, in the province of Cordova, about 28 miles S.E. of that city, situated in a fertile valley near the source of the river of the same name. It contains a cathedral church (de la Asuncion) which was formerly a mosque, and has also a theatre, a hospital, a college, and several monasteries. There still remains a part of its old castle called the Tower of Homage; and the abyss into which Don Quixote's Knight del Bosque precipitated himself is pointed out. The fields of clay in the neighbourhood afford materials for a considerable trade in bricks and pottery; and there is an abundant supply of wine, vinegar, oil, and flour from the surrounding districts. The manufacture of coarse linen, woollen, and hempen stuffs is considerable. There are some interesting Moorish remains to be seen in the town and suburbs. Cabra is a town of great antiquity and is identified with the Bæbro or Ægabro of Pliny, which was probably of Punic origin. It was delivered from the Moors by Ferdinand III. in 1240, and entrusted to the order of Calatrava, but in 1331 it was recaptured by the king of Granada. In the reign of Henry IV. it was bestowed on the count of Baena. For several centuries it was the seat of a bishop. Population 11,076.

CABUL, or KÂBUL, in modern days the capital of AFGHANISTAN (*q. v.*) The city stands on the right bank of the river called after it, on the fork made by the junction of the Loghar River, where the productive plain, which extends north to the foot of Hindu Kush, narrows rapidly into the gorges from which the streams issue. The city stands in 34° 30½' N. lat., 69° 6' E. long., at an altitude of 6396 feet above the sea.

Cabul is about 3 miles in circuit; it was formerly walled, but now is not so. The mountains surround it pretty closely except where the plain opens to the N.E. It is triangular in form, the Bâlâ-Hissâr or Acropolis, in which the Amir resides, forming the S.E. angle, and rising about 150 feet above the plain. The old wall had seven gates, of which two alone remain, viz., the Lahori and the Sirdar.

The city is divided into six *mahalas* or quarters, and these again into *kuchas* or sections, which are enclosed and have gates. In tumult these enclosures form small separate fortresses. The streets hardly merit the name, and nowhere could admit wheel carriages; they are narrow passages, frightfully dirty after rain. The houses are of sun-dried brick and wood, seldom more than two stories in height. There are no public buildings of any moment; some mosques are spacious, but none have any magnificence. There are thirteen or fourteen sarais for foreign traders, but they bear no comparison with those of Persia. The public baths lack cleanliness, and the odour of the filth which is used as fuel is most offensive. The greatest ornament of the city was the arcaded and roofed bazaar called *Chihâr Châtâ*, ascribed to Ali Mardân Khân, a noble of the 17th century, who has left behind him many monuments of his munificent public spirit both in Cabul and in Hindustan. Its four arms had an aggregate length of about 600 feet, with a breadth of 30. The display of goods was remarkable, and in the evening it was illuminated. This edifice was destroyed by Sir G. Pollock on evacuating Cabul, as a memento of the treachery of the city. The several crafts, such as saddlers, drapers, braziers, armourers, congregate together, as is usual in the East and to some extent in the south of Europe. Itinerant traders also parade the bazaars, each with his peculiar cry. The old-clothesman of London is represented by the Moghul of Cabul, with his cry of "Old bullion, old clothes!"

Including the Bala Hissar, Cabul contains about 9000 houses, giving a probable population of 50,000 to 60,000. In summer the population is more dense. Without the limits of the old city to the westward is the fortified quarter of Chandol, once a detached village, now a large suburb occupied by the Kizilbashes (see AFGHANISTAN), and containing 1500 to 2000 houses. It has independent bazaars, baths, mosques, &c.

The river of Cabul is traditionally said to have several times flooded or swept away the city. There is but one bridge within the city limits, but there are others above and below in the vicinity. The city is well supplied with water, chiefly by canals drawn from the two rivers, and the streets are frequently intersected by covered aqueducts. There are also many wells, water being found at moderate depth throughout the valley.

Though there is some malarious influence in autumn from the marshy ground north of the city, Cabul is on the whole healthy. In addition to good water it has at most seasons a fine atmosphere, and an excellent supply of food. The children are chubby and ruddy. Vast supplies of fruit of fine quality are brought into the markets from the gardens of the Koh-daman and adjoining valleys. And the shops for the sale of fruit, fresh and dried, are a notable feature in the bazaars.

Cemeteries are numerous in the vicinity, including places of Jewish and common burial. One of the graveyards near

the shrine called Shâh Shahîd contains a tomb bearing in Roman characters the following inscription :—"*Here lyes the body of* Joseph Hicks, *the son* of Thomas Hicks *and* Edith, *who departed this lyfe the eleventh of October* 1666." An annual day in spring is appropriated to visiting the tombs, as in continental Europe. The graves are sprinkled, garlands placed, and small repairs executed.

Many sacred shrines are interspersed among the cemeteries and gardens. The gardens are often on acclivities, formed into terraces, supplied with springs, and abounding in song-birds. Both shrines and gardens are greatly resorted to by the Cabulis, who are passionately fond of this kind of recreation. Most of the roads are bordered by running waters, and shadowed by mulberry, willow, or poplar trees. The tomb of the illustrious Sultan Baber stands about a mile to the west of the city in a singularly charming spot, on a slope spreading before the sun. The grave is marked by two erect slabs of white marble. Near him lie several of his wives and children; the garden has been formerly enclosed by a marble wall; a clear stream waters the flower-beds. From the hill that rises behind the tomb there is a noble prospect of his beloved city, and of the all-fruitful plain stretching to the north of it.

The geographical position of Cabul, in a tolerably open country intervening between the passes which lead to India on the one side, and those which lead to Turkestan on the other, is highly favourable to trade. Baber exalts the importance of its traffic in his day, saying that the products of Khorasan, Rûm (Turkey), Babylonia, and China were all to be found there. People in easy circumstances are numerous. The presence of a court and a considerable military force contributes to the bustle of the place, and imparts animation to many trades. But the people do not excel in any handicraft or manufacture.

Cabul is believed to be the *Ortospanum* or *Ortospana* of the geographies of Alexander's march, a name conjectured to be a corruption of *Urddhasthâna*, "high place." But the actual name is perhaps also found as that of a people in this position (Ptolemy's *Kabolitæ*), if not in the name of a city apparently identical with Ortospana, *Carura*, in some copies read *Cabura*. It was invaded by the Arabs as early as the thirty-fifth year of the Hegira, but it was long before the Mahometans effected any lasting settlement. In the early Mahometan histories and geographies we find (according to a favourite Arabic love of jingle) *Kâbul* and *Zâbul* constantly associated. Zâbul appears to have been the country about Ghazni. Cabul first became a capital when Baber made himself master of it in 1504, and here he reigned for fifteen years before his invasion of Hindustan. In modern times it became a capital again, under Timur Shah (see AFGHANISTAN), and so has continued both to the end of the Durrani dynasty, and under the Barakzais, who now reign. (H. Y.)

CABUL (Kâbul), is also the name of the province including the city so called. It may be considered to embrace the whole of the plains called Koh-daman and Beghram, &c., to the Hindu Kush northward, with the Kohestan or hill country adjoining so far as it is in actual subjection to the Amir's authority. Eastward it extends to the border of Jalâlâbâd at Jagdalak; southward it includes the Loghar district, and extends to the border of Ghazni; north-westward it includes the Paghman hills, and the valley of the upper Kâbul River, and so to the Koh-i-Baba. Roughly it embraces a territory of about 100 miles square. Wheat and barley are the staple products of the arable tracts. Artificial grasses are also much cultivated, and fruits largely, especially in the Koh-daman. A considerable part of the population spends the summer in tents. The villages are not enclosed by fortifications, but contain small private castles or fortalices. The revenue of Cabul province has been stated at £180,000.

For the CABUL RIVER, see fully under AFGHANISTAN.

CACAO. See COCOA.

CACERES, the capital of the province of the same name in Estremadura, in Spain, 20 miles south of the Tagus, and 24 miles west of Truxillo, on a ridge of hills which stretch from east to west. It is the residence of the bishop of Corias, and contains a handsome episcopal palace, as well as a public school, a college, and several charitable institutions. The monastery and college of the Jesuits was one of the finest in the kingdom, but has been secularized and converted into a hospital. In the neighbourhood are large gardens, well-cultivated fields, and extensive pasture grounds; while in the town are oil and fulling mills, soap-works, tanneries, and lime-kilns. There is also some trade in wool. Caceres occupies the site of the ancient *Castra Cæcilia*, and was a place of some importance both under the Romans and under the Moors. There are several fine specimens of the domestic architecture of the Middle Ages, such as the houses of the duke of Abrantes, the count de la Torre, and the count de los Carbajales. The bull-ring, a modern structure of granite, is one of the most remarkable buildings of its kind in Spain. Population, 13,466.

CACHAO, or, as it is variously spelled, KACHO, KECHO, HECHO, or KESHO, formerly known as Donk-king and now officially as Bacthian or Bac-king, is the largest city of Anam, and the capital of the province of Tonquin. It is situated on the west side of the Tonquin River, about eighty miles from the sea, in 105° 35′ E. long., 21° N. lat. It is of great extent. The principal streets are wide and airy, and for the most part are paved with bricks and small stones, but the others are narrow and ill paved. Most of the houses are constructed of mud or sun-burned bricks and timber, and thatched with leaves, straw, or reeds, and are generally one story in height. The public edifices are spacious, particularly the royal palace, which is several miles in circuit, and is surrounded by high walls. Besides this palace there are to be seen the ruins of one still more magnificent, said to have been six miles in circumference. Cachao is a place of some commercial resort; its imports are long cloths, chintz, arms, pepper, and other articles, which are exchanged for gold and manufactured goods, namely, beautiful silks and lackered ware, which last is generally reckoned superior to any in the East. The English factory, which stood on the banks of the river north of the city, and that of the Dutch, south of it, have long been withdrawn. Cachao is peculiarly liable to fires; and to prevent or extinguish these, the city is governed by a rigid police, and divided into wards. Fires for domestic use are only permitted during certain hours of the day. About the middle of the 18th century the city was nearly burnt to the ground by a conflagration, which was the work of incendiaries. In 1873 François Garnier, the famous French explorer, with an expedition of two hundred men and two ships, having come into collision with the authorities, took possession of the city after capturing the fort of Hanoi, which was constructed on European principles and defended by a large garrison. Not long after he was assassinated by the natives; but his victory led to a treaty between the French Government and the Anamese, by which the port is declared open to the flags of all nations.

CACHEO, or CACHAO, a town of Western Africa in Senegambia, in the land of the Papels, a few miles inland from the mouth of the River Cachao or San Domingo. It is a fortified post of the Portuguese, and carries on a trade in gold dust and ivory. Population 15,000.

CACHOEIRA, a town of Brazil, in the province of Bahia, and 62 miles N.W. from the city of that name, is situated on the River Paraguassu, which is subject to

heavy floods. It contains a town-house, a prison, a convent of Carmelites, and some five or six churches, and carries on an active trade in tobacco, coffee, and sugar. Population 15,000.

CACONGO, a small kingdom of Western Africa, separated from Congo by the river Zaire. The surface is mountainous but fruitful, the climate healthy though unsuited for Europeans. A strong tendency to adopt European customs and conveniences is displayed by the inhabitants, who carry on a considerable trade at the seaport towns of Mallemba and Cabinda. The capital is Kinguela.

CACTUS. This word, applied in the form of κάκτος by the ancient Greeks to some prickly plant, was adopted by Linnæus as the family title of a group of curious succulent or fleshy-stemmed plants, most of them prickly and leafless, some of which produce beautiful flowers, and are now so popular in our gardens that the name has become familiar. As applied by Linnæus, the name *Cactus* is almost conterminous with what is now regarded as the natural order *Cactaceæ*, which embraces several modern genera. It is one of the few Linnæan generic terms which have been entirely set aside by the names adopted for the modern divisions of the group.

The *Cacti* may be described in general terms as plants having a woody axis, overlaid with thick masses of cellular tissue forming the fleshy stems. These are extremely various in character and form, being globose, cylindrical, columnar, or flattened into leafy expansions or thick joint-like divisions, the surface being either ribbed like a melon, or developed into nipple-like protuberances, or variously angular, but in the greater number of the species furnished copiously with tufts of horny spines, some of which are exceedingly keen and powerful. These tufts show the position of buds, of which, however, comparatively few are developed. The stems are in most cases leafless, using the term in a popular sense; the leaves, if present at all, being generally reduced to minute scales. In one genus, however, that of *Pereskia*, the stems are less succulent, and the leaves, though rather fleshy, are developed in the usual form. The flowers are frequently large and showy, and are generally attractive from their high colouring. In one group, represented by *Cereus*, they consist of a tube, more or less elongated, on the outer surface of which, towards the base, are developed small and at first inconspicuous scales, which gradually increase in size upwards, and at length become crowded, numerous, and petaloid, forming a funnel-shaped blossom, the beauty of which is much enhanced by the multitude of conspicuous stamens which with the pistil occupy the centre. In another group, represented by *Opuntia*, the flowers are rotate, that is to say, the long tube is replaced by a very short one. At the base of the tube, in both groups, the ovary becomes developed into a fleshy (often edible) fruit, that produced by the *Opuntia* being known as the prickly pear or Indian fig.

The principal modern genera are ranged under two subdivisions, which are separated by the differences in the flower-tube just explained. Those with long-tubed flowers, the *Cacteæ tubulosæ*, form the genera *Melocactus*, *Mammillaria*, *Echinocactus*, *Cereus*, *Pilocereus*, *Echinopsis*, *Phyllocactus*, *Epiphyllum*, &c.; while those with short-tubed flowers, the *Cacteæ rotatæ*, are referred to *Rhipsalis*, *Opuntia*, *Pereskia*, and one or two of minor importance. These plants, whether viewed as the *Cactus* family or the natural order *Cacteæ* or *Cactaceæ*, belong almost entirely, if not exclusively, to the New World; but some of the Opuntias have been so long distributed over certain parts of Europe, especially on the shores of the Mediterranean and the volcanic soil of Italy, that they appear in some places to have taken possession of the soil, and to be distinguished with difficulty from the aboriginal vegetation. The habitats which they affect are the hot dry regions of tropical America, the aridity of which they are enabled to withstand in consequence of the thickness of their skin, and the paucity of evaporating pores or stomates with which they are furnished,—these conditions not permitting the moisture they contain to be carried off too rapidly. Occurring thus as they do in situations where ordinary vegetation could not exist, they may be considered as one of the means which nature has provided for the support of man and animals where other means of subsistence fail. The stems are filled with wholesome though insipid fluid, and the succulent fruit are not only edible but agreeable. In fevers the fruits are freely administered as a cooling drink, and when bruised are regarded as a valuable remedy for the cure of ulcers. The Spanish Americans plant the Opuntias around their houses, where they serve as impenetrable fences.

MELOCACTUS, the family of Melon-thistle or Turk's-cap Cactuses, contains, according to Labouret, a monographer of the order, about thirty species, which inhabit chiefly the West Indies, Mexico, and Brazil, a few extending into New Granada. The typical species, *M. communis*, forms a succulent mass of roundish or ovate form, from 1 foot to 2 feet high, the surface divided into numerous furrows like the ribs of a melon, with projecting angles, which are set with a regular series of stellated spines,—each bundle consisting of about five larger spines, accompanied by smaller but sharp aculei or bristles,—and the tip of the plant being surmounted by a cylindrical crown called a cephalium, 3 to 5 inches high, composed of reddish-brown acicular bristles, closely packed with cottony tomentum. At the summit of this crown the small rosy-pink flowers are produced, half protruding from the mass of wool, and these are succeeded by small red berries. These strange plants usually grow in rocky places with little or no earth to support them; and it is said that in times of drought the cattle resort to them to allay their thirst, first ripping them up with their horns and tearing off the outer skin, and then devouring the moist succulent parts. The fruit, which has an agreeably acid flavour, is frequently eaten in the West Indies. The *Melocacti* are distinguished by the distinct cephalium or crown which bears the flowers.

MAMMILLARIA.—This group, which comprises nearly 300 species, mostly Mexican, with a few Brazilian and West Indian, is called Nipple Cactus, and consists of globular or cylindrical succulent plants, whose surface instead of being cut up into ridges with alternate furrows, as in *Melocactus*, is broken up into teat-like cylindrical or angular tubercles, spirally arranged, and terminating in a radiating tuft of spines which spring from a little woolly cushion. The flowers issue from between the mammillæ, towards the upper part of the stem, often disposed in a zone just below the apex, and are either purple, rose-pink, white, or yellow, and of moderate size. The spines are variously coloured, white and yellow tints predominating, and from the symmetrical arrangement of the areolæ or tufts of spines they are very pretty objects, and are hence frequently kept in drawing-room plant cases.

ECHINOCACTUS is the name given to the group bearing the popular name of Hedgehog Cactus. It comprises some 200 species, of which more than half are natives of Mexico, and the rest are scattered through South America, extending as far south as Buenos Ayres. They have the fleshy stems characteristic of the order, these being either globose, oblong, or cylindrical, and either ribbed as in *Melocactus*, or broken up into distinct tubercles, and most of them armed with stiff sharp spines, set in little woolly cushions occupying the place of the buds. The flowers, produced near the apex of the plant, are generally large and showy, yellow and rose being the prevailing colours. They are succeeded by succulent fruits, which are exserted, and frequently scaly or spiny, in which respects this genus differs both from *Melocactus* and *Mammillaria*, which have the fruits immersed and smooth. One of the most interesting species is the *E. Visnaga*, of which some very large plants have been from time to time imported. A specimen weighing one ton, and measuring 9 feet high, and 3 feet in diameter, was received at Kew some years since, but owing to injuries received during transit, it did not long survive. These large plants have from forty to fifty ridges, on which the buds and clusters of spines are sunk at intervals, the aggregate number of the spines having been in some cases computed at upwards of 50,000 on a single plant. These spines are used by the Mexicans as toothpicks, whence the name Visnaga.

CEREUS.—This group bears the trivial name of Torch Thistle. It comprises about 150 species, scattered through South America and the West Indies. In one series, numbering between twenty and thirty species, sometimes separated under the name of *Echinocereus*, the stems are short, branched or simple, divided into few or many

ridges, all armed with sharp formidable spines; but in the greater number of species the stems are columnar or elongated, some of the latter creeping on the ground or climbing up the trunks of trees, rooting as they grow. One of the former group, *C. pectinatus*, produces a purplish fruit resembling a gooseberry, which is very good eating; and the fleshy part of the stem itself, which is called Cabeza del Viego by the Mexicans, is eaten by them as a vegetable after removing the spines. To the latter group belongs *C. giganteus*, the largest and most striking species of the genus, a native of hot arid desert regions of New Mexico, growing there in rocky valleys and on mountain sides, where the tall stems with their erect branches have the appearance of telegraph poles. The stems grow to a height of from 50 feet to 60 feet, and have a diameter of from 1 foot to 2 feet, often unbranched, but sometimes furnished with branches which grow out at right angles from the main stem, and then curve upwards and continue their growth parallel to it; these stems have from twelve to twenty ribs, on which at intervals of about an inch are the buds with their thick yellow cushions, from which issue five or six large and numerous smaller spines. The fruits of this plant, which are green oval bodies from 2 to 3 inches long, contain a crimson pulp from which the Pimos and Papagos Indians prepare an excellent preserve; and they also use the ripe fruit as an article of food, gathering it by means of a forked stick attached to a long pole. The Cereuses include some of our most interesting and beautiful hothouse plants.

PILOCEREUS, the Old Man Cactus, forms a small group with tallish erect fleshy angulate stems, on which, with the tufts of spines, are developed hair-like bodies, which, though rather coarse, bear some resemblance to the hoary locks of an aged man. The plants are nearly allied to *Cereus*, differing chiefly in the floriferous portion developing these longer and more attenuated hair-like spines, which surround the base of the flowers, and form a dense woolly head or cephalium. The most familiar species is *P. senilis*, a Mexican plant, which though seldom seen more than a foot or two in height in greenhouses, reaches from 20 feet to 30 feet in its native country.

ECHINOPSIS is another small group of species, separated by some authors from *Cereus*. They are dwarf, ribbed, globose, or cylindrical plants; and the flowers, which are produced from the side instead of the apex of the stem, are large, and in some cases very beautiful, being remarkable for the length of the tube, which is more or less covered with bristly hairs. There are about thirty species known, their geographical range extending from Mexico and Texas to Brazil, Bolivia, and Chili.

PHYLLOCACTUS, the Leaf Cactus family, consists of about a dozen species, found in Mexico and Brazil. They differ from all the forms already noticed in being shrubby and epiphytal in habit, and in having the branches compressed and dilated so as to resemble thick fleshy leaves, with a strong median axis, and terete woody base. The margins of these leaf-like branches are more or less crenately notched, the notches representing buds, as do the spine-clusters in the spiny genera; and from these crenatures the large showy flowers are produced. As garden plants the *Phyllocacti* are amongst the most ornamental of the whole family, being of easy culture, free blooming, and remarkably showy, the colour of the flowers ranging from rich crimson, through rose-pink, to creamy white. They are often called *Epiphyllum*, which name is, however, properly restricted to the group next to be mentioned.

EPIPHYLLUM.—This name is now restricted to two or three dwarf branching Brazilian epiphytal plants of extreme beauty, which agree with *Phyllocactus* in having the branches dilated into the form of fleshy leaves, but differ in having them divided into short truncate leaf-like portions, which are articulated, that is to say, provided with a joint by which they separate spontaneously; the margins are crenate or dentate, and the flowers, which are large and showy, magenta or crimson, appear at the apex of the terminal joints. In *E. truncatum* the flowers have a very different aspect from that of other *Cacteæ*, from the mouth of the tube being oblique and the segments all reflexed at the tip. The short separate pieces of which these plants are made up grow out of each other, so that the branches may be said to resemble leaves joined together endwise.

RHIPSALIS, a genus of about thirty tropical American species, contains some of the plants once referred to *Cactus*. It is a very heterogeneous group, being fleshy-stemmed with a woody axis, the branches being angular, winged, flattened, or cylindrical, and the flowers small, short-tubed, succeeded by small, round, pea-shaped berries. *Rhipsalis Cassytha*, when seen laden with its white berries, bears no inconsiderable resemblance to a branch of mistleto. All the species are epiphytal in habit.

OPUNTIA, the Prickly Pear, or Indian Fig Cactus, is a large typical group, comprising some 150 species, found in North America, the West Indies, and warmer parts of South America, extending as far as Chili. In aspect they are very distinct from any of the other groups. They are fleshy shrubs, with terete woody stems, and numerous succulent branches, composed in most of the species of separate joints or parts, which are much compressed, often elliptic or suborbicular, dotted over in spiral lines with small fleshy caducous leaves, in the axils of which are placed the areoles or tufts of glochidiate or hooked spines of two forms. The flowers are mostly yellow or reddish-yellow, and they are succeeded by pear-shaped or egg-shaped fruits, having a broad scar at the top, furnished on their soft fleshy rind with tufts of small spines. The sweet juicy fruits of *O. vulgaris* and *O. Tuna* are much eaten under the name of prickly pears, and are greatly esteemed for their cooling properties. Both these species are extensively cultivated for their fruit in Southern Europe, the Canaries, and Northern Africa; and the fruits are not unfrequently to be seen in Covent Garden Market and in the shops of the leading fruiterers of the metropolis.

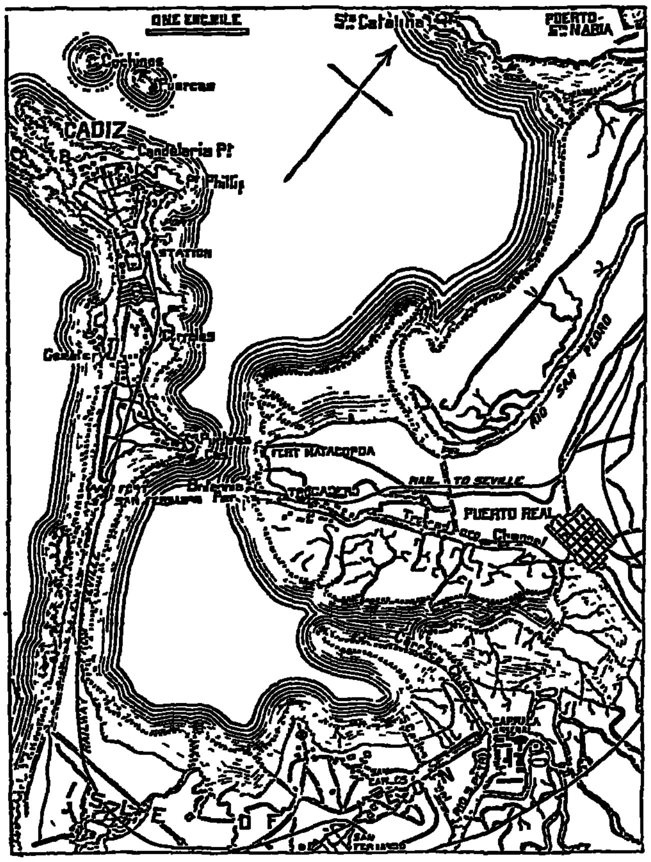
The cochineal insect is nurtured on a species of *Opuntia* (*O. coccinellifera*), separated by some authors under the name of *Nopalea*, and sometimes also on *O. Tuna*. Plantations of the nopal and the tuna, which are called nopaleries, are established for the purpose of rearing this insect, the *Coccus Cacti*, and these often contain as many as 50,000 plants. The females are placed on the plants about August, and in four months the first crop of cochineal is gathered, two more being produced in the course of the year. The native country of the insect is Mexico, and it is there more or less cultivated; but the greater part of our supply comes from New Granada and the Canary Islands.

PERESKIA ACULEATA, or Barbados Gooseberry, the *Cactus Pereskia* of Linnæus, is the only remaining generic type; and this differs from the rest in having woody stems and leaf-bearing branches, the leaves being somewhat fleshy, but otherwise of the ordinary laminate character. The flowers are subpaniculate, white or yellowish. This species is frequently used as a stock on which to graft other *Cacti*. There are about a dozen species known. (T. MO.)

CADAHALSO, JOSE DE (1741–1782), a Spanish poet and writer, was born at Cadiz in 1741. He was educated at Paris, and before completing his twentieth year had travelled through Italy, Germany, England, and Portugal, and had studied with care the languages and literatures of these countries. On his return to Spain he entered the army, and rose to the rank of colonel. He was killed at the siege of Gibraltar, 27th February 1782. His first published work was a tragedy after the French model, *Don Sancho Garcia*, printed in 1771. In the following year he published his *Eruditos á la Violeta* (Fashionable Learning), a satire on superficial knowledge, which was very successful. In 1773 appeared a volume of miscellaneous poems, and after his death there was found among his MSS. a series of fictitious letters, somewhat after the style of the *Lettres Persanes*, or the *Citizen of the World*, which were published as *Moorish Letters*, and have been frequently reprinted. The complete edition of his works, with life by Navarrete, appeared at Madrid, in 3 vols., 1818.

CADIZ (in Latin *Gades*, and formerly called *Cales* by the English), the capital of a province of the same name in Spain, is built on the extremity of a tongue of land projecting about five miles into the sea, in a direction N.W. from the Isla de Leon, in 36° 31′ N. lat., 6° 18′ W. long., 94 miles by rail south of Seville, and 13 from Xeres. The city, which is six or seven miles in circumference, is surrounded by a wall with five gates, one of which communicates with the isthmus. Seen from a distance off the coast, it presents a magnificent display of snow-white turrets rising majestically from the sea; and for the uniformity and elegance of its buildings, it must certainly be ranked as one of the finest cities of Spain, although, being hemmed in on all sides, its streets and squares are necessarily contracted. Every house in the city annually receives a coating of whitewash, which, when it is new, produces a disagreeable glare in the streets. The most characteristic feature of Cadiz is the marine promenades, fringing the city all round between the ramparts and the sea, especially that called the *Alameda* on the eastern side, commanding a view of the shipping in the bay and the ports on the opposite shore. The principal square is the Plaza de San Antonio, surrounded by handsome houses with elegant façades, the centre pleasantly shaded with trees, and furnished with numerous seats of marble. Communicating with it is the principal street (Calle Ancha), in which are the exchange and houses of the nobility. The houses are generally lofty

and well-built, with open central courts, surmounted by turrets and flat roofs in the Moorish style. The principal public buildings are the two cathedrals (one built in the 13th century, the other begun in 1720, but not completed till 1840); the Hospicio or Casa de Misericordia, adorned with a marble portico, and having an interior court with Doric colonnades; the bull-ring, with room for 12,000 spectators; the two theatres, the prison, the custom-house, and the lighthouse of San Sebastian on the western side, rising 172 feet from the rock on which it stands. Besides the Hospicio already mentioned, which sometimes contains 1000 inmates, there are numerous other charitable institutions, such as the women's hospital, the foundling institution, the admirable Hospicio de San Juan de Dios for men, and the lunatic asylum. Gratuitous instruction is



Plan of Cadiz and its environs.

A, Fort San Sebastian.
B, Fort Santa Catalina.
C, The Alameda.
1. Hospital.
2. Academy of Fine Arts.
3. Custom-House.
4. Capuchinos
5. Old and New Cathedrals.
6. Sta. Marta.

given to a large number of children, and there are several mathematical and commercial academies, maintained by different commercial corporations, a nautical school, a school of design, a theological seminary, a flourishing medical school, an *Academia de Nobles Artes* (founded in 1789, principally by the exertions of Governor O'Reilly), an excellent observatory, and a hydrographic depôt. There are several public libraries attached to the various educational establishments, but none of any note. The museum is filled for the most part with wretched copies of ancient masterpieces, but in the church of the Capuchinos, which was formerly a monastery, is an unfinished picture of the marriage of St. Catherine by Murillo, the last effort of his pencil, as he met his death by falling from the scaffold on which he was painting.

Cadiz is the see of a bishop, who is suffragan to the archbishop of Seville, but its chief conventual and monastic institutions have been suppressed. Its noble bay, more than 30 miles in circuit and almost entirely land-locked by the isthmus and the headlands which lie to the N.E., has principally contributed to its commercial importance. The outer bay stretches from the promontory and town of Rota to the mouth of the Guadalete; and the inner bay, protected by the forts of Matagorda and Puntales, affords generally good anchorage, and contains a harbour formed by a projecting mole, where vessels of small burden may discharge. The entrance to the bays is rendered somewhat dangerous by the low shelving rocks (Cochinos and Las Puercas), which encumber the passage, and by the shifting banks of mud deposited by the Guadalete and the Rio Santi Petri. On the mainland, at the mouth of the latter river, is the village of Caracca, which contains about 6000 inhabitants, and possesses a naval arsenal and dockyard; and on the isthmus are situated the well-frequented sea-bathing establishments.

The commercial greatness of Cadiz is no longer what it was in the 17th and 18th centuries. At one time it was the great focus of intercourse between Spain and the Spanish colonies; and from 1720 to 1765 it enjoyed a monopoly of the traffic with Spanish America, which had previously been in the hands of Seville. Its prosperity began to decline when the trade of San Domingo, Cuba, Porto Rico, and the other islands was opened up to the greater ports of Spain, and decayed almost entirely in the beginning of the present century, when the colonies achieved their independence. An attempt was made by the Spanish Government in 1828 to restore its former greatness, by making it a free warehousing port, but this valuable privilege was withdrawn in 1832. Since the opening of the railway to Seville and the improvements effected in the harbour, the commercial activity has greatly increased; and in spite of the disturbing influences of political revolutions, Cadiz is still one of the most important ports in Spain. It is the European terminus of many of the principal mail-lines from the colonies both in the east and west. Besides the Xeres wine, for which it received in 1872 no less than £2,458,487 from Britain alone, it exports quicksilver, brandy, oil, provisions, flour, and wool. The salt trade, which was formerly of considerable extent, is almost extinct. The imports consist chiefly of sugar and coffee from Havana and Porto Rico, English coal from Cardiff, cocoa, hemp, flax, linens, dried fish, hides, cotton and woollen manufactures, rice, spices, indigo, staves, and timber. The total number of vessels that entered in 1872 was 1140, of which 494 were steamships; and the total tonnage was 287,850. Of the sailing vessels 179 were British and 136 Italian, of the steamships 127 British and 281 Spanish. The manufactures of Cadiz are unimportant, though a considerable stimulus to industry is given by the *Sociedad economica de Amigos del Pais*, which introduced the cochineal plant, and grants medals for improvements in manufactures.

Cadiz is strongly fortified with ramparts and bastions and defended by the forts of San Sebastian, Santa Catalina, Matagorda, and Puntales Castle. On the neighbouring coast the isthmus is protected by an intrenchment called the Córtadura, or Fort San Fernando.

From its almost insular position it enjoys a mild and serene climate, the mean annual temperature being about 64° Fahr., while the mean summer and winter temperatures vary only about 10° above and below this point. From the same cause it labours under a great deficiency of water, which must either be collected in cisterns from the tops of the houses or brought at great expense from Santa Maria on the opposite coast. Population in 1845, 53,922, and in 1860, 71,521.

Cadiz is identical with the ancient Agadir, Gadir, or Gaddir (in Greek *Gadeira*), which was a flourishing Phœnician colony long before the beginning of classical history, and continued in the hands of the Carthaginians, though somewhat disaffected to them,

till after the Punic wars, when Spain became a Roman province. C. Julius Cæsar conferred the *civitas* of Rome on all its citizens in 49 B.C.; and not long after L. Cornelius Balbus Minor built what was called the "New City," constructed the harbour which is now known as Puerto Real, and erected the bridge across the strait of Santi Petri, which unites the Isla de Leon with the mainland, and is now known as the Puente de Zuazo, after Juan Sanchez de Zuazo, who restored it in the 15th century. Under Augustus, when it was the residence of no fewer than 500 *equites*, it was made a municipium with the name of Augusta Urbs Gaditana, and its citizens ranked next to those of Rome. Some remains of the ancient city, and particularly of the temple of Hercules, are said to be visible below the sea. After the fall of Rome it was destroyed by the Goths, and remained in obscurity under the Moors, from whom it was retaken by Alphonso the Wise in 1262, but it emerged again when the discovery of America made it valuable as a market for colonial produce. In more recent contests Cadiz has been subjected to several disasters. It was taken and pillaged in 1596 by the British fleet, under Essex and Howard, in revenge for the Spanish Armada. It was attacked, but without success, by Lord Wimbledon in 1626, and by the duke of Ormond and Sir George Rooke in 1702. It was bombarded by Nelson in 1800. In 1808 the Spanish patriots in Cadiz brought the French fleet, which lay in the bay blockaded by Admiral Collingwood, to a surrender; and they were in turn subjected to a protracted siege of two years by Marshal Victor, from which they were relieved by the successes of Wellington in the Peninsula. It was once more reduced by the Duke d'Angoulême in 1823, and remained in the hands of the French till 1828. In 1868 the city was the centre of the revolution which effected the dethronement of Queen Isabella.

CADMIUM, a metal closely allied to zinc. It was discovered in 1817 by Stromeyer and Hermann, independently, but in a similar manner. The former chemist, in the execution of his duties as inspector of pharmaceutical products in Hanover, found a substance, sold as oxide, to be really carbonate of zinc, and, applying to the manufacturer for explanation of the reason of the substitution of the latter product for the former was informed that, although the best zinc, in which no iron could be detected, was employed, the oxide could not be produced without a slight discoloration from oxide of iron. On investigation by Stromeyer, it was found that the discoloration was due not to iron but to the oxide of a new metal, which he succeeded in isolating, and named cadmium, from the old chemical name for zinc oxide (*Cadmia fossilis*). About the same time, the sale of an oxide of zinc supplied by Hermann, a chemical manufacturer, who produced it from the waste of the Silesian zinc furnaces, was stopped in Prussia as being contaminated with arsenic,—the reason obviously being that the acid solution of the substance in question gave a bright yellow precipitate when heated with sulphuretted hydrogen. The erroneous character of this inference was, however, soon demonstrated by Hermann, who made a careful investigation of the subject, and discovered the nature of the new metal, but not before Stromeyer had published the results of his observations.

Cadmium does not occur in the metallic state in nature, and there is only one definite mineral known which contains it in quantity, namely, the sulphide, or greenockite, which occurs at Bishopstown, in Renfrewshire, in small isolated crystals of a bright orange-yellow colour, belonging to the hexagonal system, in a doleritic rock associated with prehnite. This contains 77·7 per cent. of cadmium and 22·3 per cent. of sulphur, corresponding to the formula CdS, and is isomorphous with voltzite, the rhombohedral form of sulphide of zinc. Although an extremely rare mineral in the pure state, being confined to the single locality mentioned above, sulphide of cadmium is often present in zinc blende, the richest varieties containing 3 per cent. of cadmium. Among these are the yellow radiated blende of Przibram in Bohemia, Eaton in New Hampshire, and Engis and Corfali in Belgium. It is also found in the carbonates and silicates of zinc from most of the localities producing these ores, but in what state of combination is doubtful, as it is not generally found in quantity sufficient to be appreciated by the analysis of samples,—being only discoverable when the ore is treated for zinc on the large scale, in the first products of the reducing processes.

Cadmium is a white metal with a slight bluish tinge by reflected light; it is whiter than lead or zinc, but less so than silver, has a high lustre when polished, and breaks, under a gradually increasing strain, with the fibrous or scaly fracture characteristic of a soft tough metal. It may be readily crystallized in octohedra, differing in this respect from the allied metal zinc which is rhombohedral. It is somewhat harder than tin, but less so than zinc, and like the former metal it emits a peculiar crackling sound when bent. It is malleable, and may be rolled into thin sheets. The specific gravity after fusion is 8·604, which is increased by hammering to 8·694. The specific heat is 0·05669 (Regnault), or 0·0576 (Dulong and Petit). The electric conductivity is 22·10, or somewhat lower than that of zinc; the thermal conductivity does not appear to have been determined. It melts at a temperature below redness (315° to 320° C.), and boils at the temperature of 860° C., giving off a vapour of an orange-yellow tint. The principal coloured lines with their relative intensity observed in the spectrum of cadmium vapour are, according to Huggins's notation, 502^{4}, 639^{1}, 656^{8}, $889^{6\cdot5}$, 918^{1}, 953^{1}, 986^{1}, 1473^{10}, 1517^{10}, 1536^{1}, 1747^{1}, 1843^{10}, 2315^{8}, 2562^{6}, 3239^{4}. The most brilliant of these are chiefly in the green and blue field.

Chemically cadmium belongs to the diatomic group of elements; its symbol is Cd, and its equivalent 58. It unites readily with most of the heavy metals, forming alloys, which with gold, copper, and platinum, are brittle, while those with lead and tin are malleable and ductile. The alloy of $\frac{2}{3}$ silver and $\frac{1}{3}$ cadmium is very tenacious; but that, in the reverse proportion, of $\frac{1}{3}$ silver and $\frac{2}{3}$ cadmium is brittle. An alloy of two parts of cadmium, two of lead, and four of tin, known as Wood's fusible metal, melts at a somewhat lower point than the similar alloy where bismuth takes the place of cadmium, or Darcet's fusible metal (see BISMUTH). It forms several amalgams, among which those containing equal parts of mercury and cadmium and two of mercury to one of cadmium are remarkable for their cohesive power and malleability; whereas that containing 22 per cent. of cadmium is hard and brittle. The amalgams of the former class have been proposed at different times for use in stopping teeth, but are not now so employed. When exposed to damp air cadmium becomes rapidly covered with a dull film of suboxide, but as with zinc the oxidation is only superficial, the crust formed protecting the metal below from further change. When heated to a redness in air it burns, forming a yellowish brown oxide. It also, when in a state of vapour, decomposes water at a red heat, with the formation of oxide of cadmium, hydrogen being evolved. It is soluble with evolution of hydrogen, in sulphuric, hydrochloric, nitric, and even acetic acid, forming colourless salts. When treated with an aqueous solution of sulphurous acid, it dissolves without evolution of hydrogen, sulphite and sulphide of cadmium being found in the liquid.

Oxide of cadmium, CdO, is a yellowish brown powder of the specific gravity 6·95, varying in depth of tint according to the temperature at which it is prepared. It may be produced by burning the metal in air or by calcining the nitrate or carbonate. It is readily reducible by hydrogen or carbon, at a high temperature, but below that necessary for the reduction of zinc oxide. If a mixture of the oxides of the two metals be heated in a current of hydrogen in a glass tube, the oxide of cadmium is reduced, volatilizes, and condenses in the cooler part of the tube, while the oxide of zinc remains unchanged. Oxide of cadmium is a strong base, forming salts similar in constitution to those formed by oxide of zinc, and those of the earthy and alkaline metals. The most important of these is the sulphate,

$CdSO_4$, which is produced when the metal or its oxide is dissolved in sulphuric acid, forming crystals containing either one or four atoms of water, the former being deposited from a boiling solution, and the latter at the ordinary temperature of the air. The uses of cadmium salts are very limited; the sulphate is employed to a small extent as a lotion in inflammation of the eyes, similarly to the sulphate of zinc, and the iodide in photography and in medicine for the same purposes as iodide of potassium. The only compound of any real importance is the sulphide, CdS, which produces several brilliant yellow and orange colours. These are quite permanent, unlike the yellow produced by lead, chromium, or other metals, which are all more or less subject to discoloration when exposed to the action of sulphuretted hydrogen in the atmosphere. It is produced when sulphuretted hydrogen, or an alkaline sulphide, is added to the solution of any cadmium salt, as an orange-red powder, which becomes carmine-red when heated. At a white heat it melts, and solidifies on cooling in lemon-yellow scales of a micaceous structure. When the precipitated sulphide is heated in hydrogen it is decomposed, forming cadmium vapour and sulphuretted hydrogen, which reunite in the cooler part of the tube, producing crystals exactly similar to the native mineral greenockite.

The best test for cadmium is afforded by the colour of the deposit formed on charcoal when it is volatilized and oxidized before the blowpipe flame. This is of a reddish brown colour, and usually shows the colours of thin plates from the tenuity of the film; whereas zinc under the same conditions gives a deposit which is bright yellow while hot, but becomes white on cooling. The precipitation as a yellow sulphide from an acid solution is another distinguishing character, as sulphide of zinc does not separate except from neutral or alkaline solutions. In quantitative analysis it is always estimated as oxide, being separated from solution as carbonate by precipitation with carbonate of sodium, which is converted into oxide by calcination. Cadmium, like lead, may also be separated from its solution in acids by means of zinc, which precipitates it in a dendritic form, like the well-known lead tree.

The production of cadmium is restricted to a very few localities. At Engis in Belgium it occurs in zinc blende to the extent of about 0·2 per cent. The oxide formed, together with oxide of zinc in the calcination of the blende, is in the subsequent reducing process in the ordinary Belgian zinc furnace (see ZINC), reduced and volatilized in the first period of the operation, before the heat is raised sufficiently to produce much zinc vapour, and the vapour, on coming in contact with the air, burns with a characteristic brown flame as distinguished from that of zinc, which is bluish green. The deposit formed in the condensing tubes, and in the nozzles (*allonges*) in front of the retorts, during this part of the process is comparatively rich in cadmium oxide, averaging about 1½ per cent. It is put aside until a sufficiency is collected, when it is enriched by a second distillation up to about 6 per cent., this second product being finally reduced by a third distillation with carbon at a dull red heat. The furnace contains fifteen retorts, four of which are reserved for the reduction of the enriched oxide. Cast-iron tubes are used, as the vapour of the metal readily penetrates clay retorts. The loss on the process is very considerable, only 30·12 per cent. of the whole amount of cadmium contained in the material treated being recovered; 21·17 per cent. is left in the residues, and 48·71 per cent. escapes condensation. The total produce of cadmium is very small; about one-half of the amount is produced at Engis, and the remainder in Silesia. In 1874 the production of cadmium in Lower Silesia amounted to 25 cwt., valued at £990 or about £800 per ton; but owing to the small demand many works had given up the manufacture. (H. B.)

CADMUS, in Greek Legend, was the founder of the town of Thebes originally called Cadmeia, and according to the tradition was a son of Agenor, king of Phœnicia, whence he had proceeded to Greece in search of his sister Europa, but failing to find her had, in obedience to an oracle, settled at Thebes. He there founded a town over which he in time became king, received from the gods Harmonia, a daughter of Ares and Aphrodite, as his wife, by her had a family on whom fell heavy misfortunes, and finally retired with her to Illyria, where they both died in peace, and were transformed into snakes which watched the tomb while their spirits were translated to Elysium. At the marriage all the gods were present, and the muses sang. Harmonia received a dress (*peplos*) worked by Athena, and a necklace made by Hephæstus. Their offspring were Semele, Ino, Autonoë, Agave, and a son Polydorus. On his first settlement at Thebes, Cadmus had slain a dragon, which guarded a spring, and at the orders of Athena had sown its teeth in the ground, from which there sprang a race of fierce armed men (Spartoi). By throwing a stone among them Cadmus caused them to fall upon each other till only five survived, and they became the founders of the noblest families of Thebes. Cadmus, however, because of this bloodshed, had to do penance for a long year (*i.e.*, eight years). Such is the legend. When Greek writers came to explain it they identified Cadmus as a Phœnician hero who had introduced into Greece the Phœnician writing, mining, and other arts or institutions of civilization. But his name is Greek rather than Phœnician, and like Cadmilus in Samothrace appears to mean "order," and to indicate a person who has instituted order in a state. He may have adopted much from the early Phœnician traders; but from the fact of Thebes having been one of the seats of the primitive Pelasgi, and from the occurrence of Cadmilus in Samothrace, also a seat of the Pelasgi, it is very probable that Cadmus was originally a purely Greek hero.

CADUCEUS (*κηρυκεῖον*), the symbol of office carried by public heralds, by Mercury (Hermes), as herald or messenger of the gods, and by Iris, Victory, and Eirene. It consisted of a staff round which two serpents were twined in a knot, their heads meeting at the top of the staff. Mercury, it was said, had seen two serpents fighting and knit together so, and had chosen this as a symbol of the quarrels which it was his duty to assist in settling. Sometimes a pair of wings are attached to the staff to indicate the speed of Mercury as a divine messenger. In the British Museum there is a bronze caduceus, found in a tomb in Sicily, which appears, from the inscription engraved on it in early Greek letters, to have belonged to a public herald of the town of Longena.

CÆDMON, or CEDMON (the former way of spelling is that of Bede, the latter that of Florence of Worcester), is the name of the earliest Anglo-Saxon or Old English poet of whom we have any knowledge. The meaning of the name has been much disputed. Sir Francis Palgrave, despairing of finding a native derivation, suggested (*Archæologia*, vol. xxiv.) that the poet might have been so called from the Chaldaic name for the book of Genesis, which is "b' Cadmin," in the beginning, or "Cadmon," beginning, from the opening words of the first chapter of Genesis. He thought that he might even have been an "Eastern visitor," who had arrived in Britain from the East, mastered the language, and come out as a vernacular poet. A hypothesis so fanciful as this last may be at once rejected. Another suggestion of the same lively writer connects the name with the Adam Cadmon (the primitive and ideal man) of the Cabalists. It is true that Cabalistic speculations cannot be traced back with certainty beyond the 9th century, but it is quite possible that the word may have

been recognized as an important word in the East, and as bearing a distinct philosophic or theosophic meaning at a far earlier date. On the other hand, in favour of the view which gives to the name a native origin, it may be urged that Bede, though he only employs the word once, says in that passage that the poet's nocturnal visitant "called him by his name," and said, "Cædmon, &c." Does not this look as if the name had a homely and north-country sound in Bede's ears? If so, What did it mean? Sir Francis Palgrave maintains that no Anglo-Saxon derivation can be found for the first part of the name. Dr Bouterwek, however (in a work on Cædmon, published at Elberfeld in 1845), together with Professor Sandras, explains *ced* as meaning a boat in Anglo-Saxon, whence the former translates the name "pirate," the latter "boat-man." This would be satisfactory if it rested on any ground of fact; but unfortunately this word "ced" is a pure invention of Professor Bouterwek's; neither the Anglo-Saxon language, as known to us, nor the Old English of the first three centuries after the Conquest, nor any local dialect contains any such word. On the whole, Sir Francis Palgrave's first suggestion seems to involve the least difficulty. "Cadmon" means "beginning" in the Targum of Onkelos, the Chaldee version of the Scriptures, which was in popular use among the Jews from the 1st century B.C. downwards, and some learned ecclesiastic at Whitby who had visited the Holy Land may have given to the poet the name Cadmon (which in Anglo-Saxon mouths became Cædmon), because he was to sing of the "beginning" of things.

The few particulars that are known of the life of Cædmon are all to be found in Bede's *Ecclesiastical History*, a book so well known that an abridgement of them is all that will be necessary here. Cædmon was probably a ceorl, employed under the "villicus" or bailiff of the lands belonging to the monastery of St Hilda at Whitby. He had arrived at mature age, and had embraced Christianity at the call of the devoted Irishmen who from Iona and from Lindisfarne, through two-thirds of the 7th century, spread the light of faith through the regions of northern England. He used to attend festive meetings; but when the song went round, and the harp was passed into his hands, Cædmon, ignorant of the rough old battle-songs of the heathen time, could sing nothing. On one such occasion he is said to have left the feast and gone to the stables, where it was his turn that night to attend to the horses and plough-oxen. He fell asleep, and dreamed that a person appeared to him, who, calling him by his name, said, "Cædmon, sing me something." On his replying that he could not sing, and that on this account he had left the revellers, the other replied, "Nevertheless thou shalt sing for me." "What," said Cædmon, "must I sing?" "Sing," he answered, "of the beginning of created beings" (*principium creaturarum*). Thereupon Cædmon began to sing verses which he had never heard or learned, praising and magnifying the Creator who had made heaven and earth for the children of men. Awaking from his sleep he remembered the verses which had come to him in his dream, and added others to them.

In the morning he went to the bailiff who was over him and told him what had happened; the bailiff took him to the abbess. St Hilda assembled a company of pious and learned persons, and before them trial was made of Cædmon's gift. He told his story, and repeated the verses, and they all judged that he had received an inspiration from above. They explained to him then and there a passage from holy writ, and desired him to versify it. He went away and returned the next morning with his task most excellently performed. The abbess then received him "*cum omnibus suis*" (it is not easy to determine whether this phrase applies to his kith and kin or merely to his worldly goods) into the monastery; and there he lived as a monk for the remainder of his life, employing diligently his leisure hours in the cultivation of the gift which he had received. The English poets who, up to the time when Bede wrote, had attempted to write religious poems in imitation of Cædmon, had, in the historian's opinion, fallen far short of him. How long he lived in the monastery we are not informed. The narrative of his death, beautiful in its piety and simplicity, relates how, after an illness of fourteen days, he desired to be removed to the infirmary, where, on the same night, after receiving the Eucharist by way of viaticum, and "signing himself with the sign of the holy cross," he sank into a peaceful slumber from which he never woke.

Florence of Worcester speaks of him, under the year 680, as that celebrated monk of St Hilda's Abbey who had received from heaven the free gift of poetic inspiration. William of Malmesbury, in the *Gesta Pontificum* (lib. iii. § 116), says that his relics had been discovered at Whitby shortly before he wrote (early in the 12th century), and had been, according to popular report, the occasion of miracles.

An important question remains— whether Cædmon was really the author of the metrical paraphrase of Genesis, Exodus, part of the book of Daniel, &c., which usually goes by his name. The unique MS. containing this paraphrase came into the hands of Archbishop Usher in the 17th century, and was by him given to the French scholar, Francis Dujon, better known as "Junius," who bequeathed it to the Bodleian Library It is in a hand of the latter part of the 10th century, and contains no indication of authorship. The poem opens as follows:—

Us is riht micel thæt we rodera weard,
Wereda wuldor-cining, wordum herigen,—

(For us it is very right that we should praise with our words the Guardian of the heavens, the glorious King of hosts.) A number of very curious illustrations, etchings heightened with green and red colour, are in the earlier portion of the MS.; engravings of them may be seen in the 24th volume of the *Archæologia*. Obviously the only means of identifying this anonymous poem as the work of Cædmon is to compare it, as to its opening and contents, with the poem described by Bede. The substance of Cædmon's opening, according to Bede, was this: "Now we ought to praise the author of the heavenly kingdom, the power of the Creator and His counsel, the deeds of the Father of glory. How He, since He is eternal God, is the author of all wonders, who, the Almighty Guardian of the human race, first created for the sons of men the heaven to be the roof of their abode, and afterwards the earth." The opening of the paraphrase, though more diffuse, agrees with that here described pretty well as to its general meaning, except that the heavens are represented in it as created for the angels rather than for the children of men, who do not come upon the scene till later. Were there no other evidence, it might seem not unreasonable to identify the paraphase with the poem of Cædmon. But here a new difficulty meets us. King Alfred translated Bede's *Ecclesiastical History*, and when he comes to this passage he gives us a metrical version of Bede's Latin description of the opening, which he seems to intend his hearers to take for the *ipsissima verba* of Cædmon. Of this there are two indications:—first, he renders Bede's words, "quorum [sc. versuum] iste est *sensus*," into "thara endebyrdnes this is," "their *order* is this;" secondly, he *omits* a long sentence immediately following the description of the opening, in which Bede explains that from the difficulty of translating verses literally from one language into another he has merely given the *sense* and not the "ordo ipse verborum." Now Alfred tells us that he *does* give the order (endebyrdnes) of the words and he leaves untranslated the passage which

affirms that only the general sense is given The verses which he inserts begin thus:—

> Nu we sceolon herian heofon-rices weard,
> Metodes mihte and his mod-gethonc,—

(Now must we praise the Warder of the heavenly kingdom, the might of the Creator, and the thought of His mind.) In short, Bede's description is turned with great literalness into Anglo-Saxon verses. But are these Cædmon's? If they are, then the paraphrase is not the work of Cædmon; for not one line in the opening as given by Alfred agrees with the paraphrast's opening However, in spite of the circumstances mentioned above, the judgment of criticism will not identify Alfred's verses with the true work of Cædmon. They are so bald, so literal, that the conviction forces itself upon us that Alfred is here merely translating from Bede's Latin, and amusing himself with making his version metrical On the other hand the paraphrast is a genuine poet; variety, force, and colour are the ever-present attributes of his poetic diction; his imagination is bold and fertile; his moral purpose clear and pervading—in fact he is just such a man as we should conceive the real Cædmon to have been.

The other point of comparison between the paraphrase and Bede's description relates to the *contents* of Cædmon's poem. "He sang," says the historian, "the creation of the world, the origin of man, and all the history of Genesis; and made many verses on the departure of the children of Israel out of Egypt, and their entering into the land of promise, with many other histories from holy writ; the incarnation, passion, resurrection of our Lord, and His ascension into heaven; the coming of the Holy Ghost, and the preaching of the apostles; also the terror of future judgment, the horror of the pains of hell. and the delights of heaven." With this account the contents of the paraphrase which we have agree, up to a certain point, remarkably well. It may be said, generally. to embrace the whole history of Genesis, except that portion which relates to events posterior to the time of Isaac. It then passes to the history of Moses and his statutes, "Moyses dómas," briefly giving the thread of events till it arrives at the passage through the Red Sea, on which the writer enlarges with evident enjoyment. An abrupt transition is then made to the book of Daniel; the story of the three children saved out of the fiery furnace is told; Daniel's dream-wisdom is set forth, and the doom denounced against Belshazzar. Then what is called the second book of the paraphrase, the beginning of which coincides with a change of handwriting in the MS., commences, and now the resemblance to Bede's description ceases. This book opens with the complaints of the fallen angels in hell and the lamentations of the souls detained in the *Limbus Patrum;* the descent of Christ after his passion to liberate these souls is described; the resurrection is barely mentioned, but the intercourse of Christ with his apostles previous to his ascension, and the ascension itself, are told at some length. The book concludes with a description of the terrors of the Day of Judgment. Such a poem cannot be said to correspond with Bede's description; but then it must be remembered that, partly on account of the change of hand and of subject, partly on account of the presence in it of later linguistic forms, the ascription of this second book of the paraphrase to the author of the first has always been held problematical. On the whole, although the grounds of a confident judgment do not exist, the analysis of the evidence here attempted points to the conclusion that the first book of the paraphrase, though not the second, may with considerable probability be assigned to Cædmon.

Some writers have assigned other extant poems to Cædmon, *e.g.*, the *Halga Rôd* (Holy Rood) of the Vercelli codex, a passage in which has been found to tally with the Runic inscription on the Ruthwell Cross, and also the fragment called *Judith*, in the MS. volume containing *Beowulf*. But the evidence in favour of either supposition may be set down as *nil;* nor does the style in *Judith*, still less in the *Halga Rod*, agree with that of the Paraphrast. (T. A.)

CAEN, or, as it is called in the old chronicles, CADON, CATHIM, CAHEM, or CAAM, the capital of an arrondissement in the department of Calvados in France. It stands about 80 or 90 feet above the level of the sea, in an extensive valley, on the left bank of the Orne, at the influx of the Odon, 9 miles from the English Channel, and 122 west of Paris, in 49° 11′ 14″ N. lat., 0° 21′ 15″ W. long. The town is handsome and well built; the streets, of which the most important is the Rue St Jean, are generally wide, straight, and clean; and the houses, being of freestone, have a very good appearance. Hardly any remains of its once extensive ramparts and towers are now to be seen; but the castle, founded by William the Conqueror and completed by Henry I., is still employed as barracks, though in a greatly altered condition. The city contains several ancient churches and other buildings, affording fine specimens of the Norman style of architecture. Among these are the church of St Pierre, dating from the 14th century and surmounted by a handsome stone spire, the finest in Normandy, 242 feet in height; the magnificent churches of the Abbaye Aux Hommes, or St Etienne, and the Abbaye Aux Dames, or Trinity, both founded in 1066,—the former by William the Conqueror, where a plain grey marble slab in the pavement now marks his long since desecrated tomb, and the latter by his queen Matilda, who was interred there. The old convent of the Capuchins is now occupied by the society of Le Bon Sauveur, which, founded by two poor girls about 1730, has grown into a most important institution, and maintains an asylum for the insane of both sexes, a charitable dispensary, a school for the education and industrial training of deaf and dumb children, and various minor establishments. Caen is the seat of a high court of appeal for the departments of Calvados, Manche, and Orne, and has tribunals of primary instance and commerce, a chamber of commerce, a *conseil de prud'hommes*, a university (founded in 1431 by Henry VI. of England), a royal college, a school of hydrography, a public library of 45,000 volumes. an extensive botanic garden, a museum belonging to the society of Norman antiquaries, and a theatre. There is a local *Académie des sciences, arts, et belles-lettres*, which has published a series of *Mémoires* since 1754. The commerce of Caen is considerable. It exports barley, flour, potatoes, wine, brandy, fruit, cattle, hardware; and imports timber from Norway, coal, pig-iron, oats, wheat, and oil-seeds. Its manufactures are of comparatively small importance with the exception of rape and colza oil, though there is a certain turn-out of caps, table-linen, cotton fabrics, leather, earthenware, and cutlery; breweries, dye-works, and ship-building yards are also in operation. The manufacture of lace, formerly of great extent, has very much declined. A fine kind of oolitic stone, in great favour as a building material, is quarried in the neighbourhood. Several large fairs are held annually. At high water, vessels of 150 or 160 tons can come up to the harbour, which consists of a part of the river bed and a basin 1896 feet in length by 164 in breadth, and has communication with the sea not only by the river, but also by a canal debouching at Ouistreham. A canal to connect it with the sea is in course of construction, which will render it accessible to large vessels. The town is situated on the main line of railway from Paris to Cherbourg, and is connected by branch lines with Courseulles on the coast, and with Laval inland.

Though Caen is not a town of great antiquity, the date of its foundation is unknown. It existed as early as

the 9th century, and when, in 912, Neustria was ceded to the Normans by Charles the Simple, it was a large and important city. Under the dukes of Normandy, and particularly under William the Conqueror, it rapidly increased. It became the capital of Lower Normandy, and in 1346 was besieged and taken by Edward III. of England. It was again taken by the English in 1417, and was retained by them till 1459, when it capitulated to the French, in whose possession it has since continued. In 1793 the city was the focus of the Girondist movement against the Convention. Among the numerous celebrities to whom Caen has given birth may be mentioned Malherbe, Boisrobert, Huet bishop of Avranches, and Tannegui Lefebvre. Population in 1872, 39,415 in the city, and 41,210 in the commune.

See L'Abbé de la Rue, *Essais historiques sur la ville de Caen*, 1820–42; Mancel, *Histoire de la ville de Caen*, 1844; Vauthier, ditto, 1843; L'Abbé Daniel, *Embellissements de la ville de Caen*, 1842; Freeman's *Norman Conquest*, vol. iii.; Macquoid's *Normandy*, 1874.

CÆRE (Καῖρε), called by the Greeks *Agylla* (Ἄγυλλα), which is probably an Etruscan name, a city of Southern Etruria, near the coast of the Tyrrhenian Sea. Its site is occupied by the modern Cervetri (*Cære vetus*), situated in the district of Civita Vecchia, about 32 miles from Rome. In the Virgilian legend of Æneas, Cære appears as the seat of the Etruscan king Mezentius; but the earliest fact in its genuine annals is its participation in an attack on the city of Alalia in Corsica. It afforded a refuge to the Tarquins on their expulsion from Rome, and it was afterwards chosen by the Romans as the securest hiding-place of their treasures during the Gallic occupation of their city. In the time of Strabo the city had become of little importance, and was even outgrown by the neighbouring village of *Aquæ Cæretanæ* It continued, however, to rank as a municipium, and in the 4th century of the Christian era had a "bishop" of its own; but in 1250 it was deserted by a large part of its inhabitants, who removed to what is now the village of *Ceri*. The chief building of modern date in Cervetri is the castle of the Ruspoli family, who are in possession of the seigniory From the inhabitants being admitted to the privilege of Roman citizenship, but without the right of suffrage, the "Cærite franchise" came to be a proverbial expression denoting disfranchisement. A large number of interesting Etruscan remains have been found in the tombs of Cære, among which may be specially mentioned paintings of high antiquity and inscriptions showing one of the sepulchres to have belonged to the Tarquin or Tarchnas family.

See Dennis, *Cities and Cemeteries of Etruria*, vol. ii.; Visconti, *Antichi monumenti discoperti nel ducato di Cere*, 1836; Canina, *Descrizione di Cere Antica*, 1838; Griffi, *Monumenti di Cere Antica*, 1841; *Transactions of the Royal Society of Literature*, vol. ii.; Noël des Vergers, *L'Étrurie et les Étrusques*, 2 vols. 1862–4; Aug. J. Hare, *Days near Rome*, 1875, vol. iii.; *Journal des Savants*, 43, &c.; and various articles in the *Annali* and *Bulletino dell' Inst. di Corrisp. Archeol. di Roma*, especially 1869, 1873, and 1874.

CAERLEON, the *Isca Silurum* of the Romans, is situated upon the right bank of the river Usk, about $3\frac{1}{2}$ miles N. of Newport in Monmouthshire. Its name appears to be a corruption of the Latin *Castrum Legionis*,[1] and there can be no doubt that the place was the station of the second Augustan legion and ranked as a colony and capital of Britannia Secunda in the period of Roman dominion. The existing remains of ancient Caerleon still *in situ* are unimportant, consisting only of fragments of the city walls and a grass-grown amphitheatre (comprising an area of 222 feet by 192 feet), in which the tiers of seats are indistinctly visible. The hamlet on the opposite bank of the river preserves its Roman name of *Ultra Pontem*, and it is probable that the connecting bridge was a pontoon similar in character to that which survived to the close of the last century. The local museum is rich in objects of interest, collected (chiefly through the zeal of Mr J. E. Lee, the author of *Isca Silurum*), either in Caerleon or its immediate neighbourhood. It includes a tesselated pavement of much beauty brought from Caerwent, four Tuscan pillars which are thought to have supported a temple of Diana, a large number of inscribed and sepulchral stones, a series of coins from the time of Otho to that of Honorius, stone coffins, *amphoræ*, *antefixa*, amulets, enamels, and Samian ware of home and foreign manufacture. It is remarkable that on two inscriptions the name of Geta (the younger son of Severus) has been mutilated and partially effaced—evidence of the hatred in which the civil governor was held by his brother Caracalla. In the recent restoration of the Parish church (in style Early English, with traces of rude Norman) a good deal of Roman masonry was brought to light, and upon the hill side, which formed the burial place of the ancient city, fragments of urns and memorial slabs are even now often exhumed. Enough has been discovered to prove that Caerleon was a place of great importance in Roman times, but not enough to support the hyperbolical language of Giraldus Cambrensis (borrowed from Geoffrey of Monmouth) that its "splendid palaces, with their gilded roofs, once emulated the grandeur of Rome" (bk. ix. c. 12).

Although the chief historic interest attaching to Caerleon is derived from the impress left upon it by Roman occupation, it has also a less substantial claim to notice in connection with the romance of Arthur and the Round Table. It was hither the "blameless king" came at Pentecost to be crowned, and made high festival with the chieftains from Lothian and Orkney, from Gower and Carados. Here, too, if we follow the laureate's version, Arthur took counsel with "Dubric, the high saint" and Guinevere climbed—

> "The giant tower, from whose high crest, they say,
> Men saw the goodly hills of Somerset,
> And white sails flying on the yellow sea.
> (*Idylls of the King, Enid.*)

The lofty mound upon which this tower is said to have stood is close to the Roman amphitheatre, to which the name of Arthur's Round Table has been given. The tumulus is evidently artificial, and may perhaps have supported the keep of the castle mentioned in *Domesday*, the ruins of which, now limited to a solitary bastion on the river side, were very extensive even in Leland's time.

The grantee of Caerleon at the Norman Conquest was William de Scohies, and the lordship was subsequently enjoyed by the Crown and the great families of Clare and Mortimer. From the latter it devolved to King Edward IV., and in later times has been held by the Morgans of Llantarnam and the Howes, Lords Chedworth. The chief proprietor at the present time is Sir Digby Mackworth, Bart.

The ecclesiastical history of Caerleon reaches back to the first introduction of Christianity into Britain, when it was constituted the seat of an archbishopric. It sent a representative to the councils of Sardis (347 A.D.) and Rimini (359); and in the persecution of Diocletian during the previous century two of its citizens, Aaron and Julius, are said to have suffered martyrdom. The see was transferred to St David's in the 11th century, and at the present time Caerleon is included within the diocese of Llandaff. Some remains of a Cistercian priory may still be traced, but even the memory of Dubricius, the stout opponent of the Pelagian heresy, has perished with his dwelling-place. (C. J. R.)

CAERMARTHEN. See CARMARTHEN.

CAERNARVON. See CARNARVON.

[1] Nennius, writing about two centuries before Geoffrey of Monmouth, says (c. 56), "Bellum gestum ... Leogis, quæ Britannice Cair Lion dicitur."

CÆSALPINUS, Andreas (1519–1603), one of the most distinguished of the Italian natural philosophers of the Renaissance, was born at Arezzo in Tuscany in 1519. Of his family nothing is recorded, nor does he appear to have left any progeny, or to have been married.

We have no account of his life till we find him seated in the botanical chair of the university of Pisa, where also he studied, if he did not teach, anatomy and medicine. His first publication was entitled *Speculum Artis Medicæ Hippocraticum*, in which it were too much to expect he should have released himself from the shackles of his venerable guide; but he has left evident proofs, in a passage often quoted, of his having a clear idea of the circulation of the blood, at least through the lungs. In botany his inquiries were conducted on a more original plan, and their result was one of the most philosophical works in that science, issued from the press at Florence in 1583, in one volume quarto. The title-page is sufficiently arrogant in tone.—*De Plantis libri XVI. Andreæ Cæsalpini Aretini, Medici clarissimi doctissimique, atque Philosophi celeberrimi ac subtilissimi;* yet Cæsalpinus appears to have been the editor, and prefixed, in his own name, an elegant and learned epistle dedicatory to Francis de' Medici, grand duke of Tuscany. This book, now rarely to be met with, is not only the unacknowledged source from which various subsequent writers, and especially Morison, derived their ideas of botanical arrangement, but it was a mine of science to which Linnæus himself gratefully avowed his obligations. Linnæus's copy of the book evinces the great assiduity with which he studied it; he has laboured throughout to remedy the defect of which Haller complains of the want of synonyms, has subjoined his own generic names to nearly every species, and has particularly indicated those remarkable passages, at pages 13 and 15, where the germination of plants and their sexual distinctions are explained. In the former we trace the first rudiments of a natural classification of plants by the differences in their cotyledons, or, in other words, we find the origin of the natural systems of Linnæus and Jussieu; in the latter passage we detect the fundamental principle of the Linnean artificial system. Nor were these merely incidental suggestions of the author. He pursued his inquiries to a conclusion on which the existence of botany as a science depends, and which the no less eminent Conrad Gesner detected about the same time, though his ideas respecting it were not then made public. The principle to which we allude is the classification of plants by their parts of fructification alone. This was afterwards extended, by the greatest writers on the subject, as Ray and Tournefort, and more completely by Linnæus, to the discrimination of their genera by the same parts, more particularly considered and contrasted. To this more extensive conclusion, indeed, the principle directly and inevitably leads. Cæsalpinus used it himself with such success as to develop some of the most important characters for generic distinctions, such as the flower being superior or inferior with respect to the fruit; the heart of the seed situated at its summit or base; the seeds, or the cells of the seed-vessels, solitary or otherwise; the partitions of certain pericarps parallel or contrary to their valves. Linnæus remarks that Cæsalpinus, though the first systematical botanist, found out as many natural classes, or orders, as his followers. He did not indeed define well the philosophical limits of genera in the vegetable kingdom, and therefore his work cannot be regularly quoted throughout for generic synonyms. The want of plates of his own, and of references to other authors, renders, as we have already hinted, some of his names and descriptions unintelligible. Yet Linnæus has in manuscript filled up many blanks which he had been obliged to leave in his own *Classes Plantarum*, where the system of Cæsalpinus first assumed a synoptical form. The latter might probably have adopted a more clear and methodical mode of arranging and explaining the botanical part of his subject, had he not had in view the vague and desultory manner of Pliny, whom he closely imitates in the materials of his numerous chapters, as well as in his style of description. A small and unimportant *Appendix* to this work, of nineteen pages, appeared at Rome in 1603, which is of very rare occurrence, but may be found reprinted in Boccone's *Museo di Piante Rare*, p. 125. The *herbarium* of over 760 plants which he left is said to be still preserved at Florence.

Cæsalpinus having been settled at Pisa when the great Galileo first presumed to doubt the infallibility of the Aristotelian philosophy, and, most likely, at the time when that rising philosopher became professor of mathematics in the same university, we can hardly imagine him to have been free from the party-spirit which so disgracefully manifested itself there. He seems to have retained his professorship till 1592, when he removed to Rome in attendance on Pope Clement VIII. He died in 1603 at the age of eighty-four.

Cæsalpinus printed at Rome, in 1596, a quarto volume of above two hundred pages, entitled *De Metallicis*, dedicated to Pope Clement VIII. which, like his botanical publications, is now extremely rare. In the philosophy of this work Aristotle is his guide; in its method and composition, Pliny. A prefatory address to the pope declares it to have been undertaken in opposition to a certain treatise on the same subject, which, though written with diligence and elegance, contained many things inconsistent with the principles of philosophy, and subversive of the Peripatetic doctrines, and with the author of which, as being excommunicated by the holy church of Rome, no measures were to be kept.

The *Quæstionum Peripateticarum libri quinque*, published at Rome in 1603, diverge considerably from the pure doctrine of Aristotle, and by the emphasis laid on the universal and common intelligence inherent in matter, approximate rather to the pantheism of the Stoics.

CÆSAR, Caius Julius, was born July 12, 100 B.C., according to others in 102 B.C., of a family who for many years had held high offices in the state. He was the greatest man of the Roman or perhaps of all the ancient world. It is not without reason that his name has remained among us as the title of sovereignty, or that his memory survives as the standard of commanding greatness; yet the very completeness of his character makes it difficult to obtain a clear grasp of his individuality. In every relation of life he attained apparently without effort to the highest excellence, as a citizen, a politician, an orator, a general, a companion, a man of letters, and a far-seeing organizing statesman. Yet study will make it clear to us that his greatness has not been overrated, and the more we contemplate his position and his work, the less opportunity we shall find for blame or criticism. He entered into active life at a great crisis of his country's history. A strong national individuality, firmness and unity of character and purpose had gradually won for Rome the supremacy of Latium, of Italy, and of the world. But the qualities which were able to acquire an empire were not able to govern it. The time was now passed when the senate presented an example of dignity and magnanimity, when a sense of law and justice and persistency of aim and object sufficed to extenuate a cruelty which knew no limit but the realization of its will. It was truer now than in the time of Horace that Rome was falling by the weight of its own greatness. The long struggle between the patricians and plebeians for political equality served rather to strengthen than loosen the cohesion of the state. But the nations which lay outside the city could not be assimilated without severe struggles. The equality of Latins and Italians with the citizens of Rome might be

won by the efforts of a demagogue, but could only be assured by an entire change of government. Failure to effect the purposes of government had diminished the sense of responsibility in the ruling class. Jugurtha had been able to discover that Roman virtue was accessible to bribes. The direction of provinces at once gratified and stimulated the avarice of statesmen. The riches of the world which were beginning to flow into the imperial city excited the desire for more. There existed at the same time the demoralization which accompanies the breaking up and abandonment of old principles of conduct, and an unsettled yearning for the adjustment of pressing difficulties. We may credit the Gracchi with a far-seeing grasp of the wants of their country, but they could not but appear to their contemporaries as mischievous revolutionists. Sulla attempted to give new strength and power to a system which had sunk into hopeless decay. Marius was inspired rather with a rough contempt for expedients which could never be successful, than with a patriotic desire to elevate the people from whom he sprung. The impotence of statesmen to understand or to regulate the age led to the employment of violence and bloodshed. A domestic enemy had forced the gates of Rome, and each political victory was sealed with the blood of the vanquished. The senate which had conquered the world was unable to defend itself; it could neither recover its former power nor bring into being a new constitution. It could not exercise the ordinary functions of government without entrusting to a citizen powers which might be turned against its own existence. It is difficult to imagine what would have been the destiny of a world from which the cohesive force which bound it together might at any time be removed. If Rome had perished in this crisis she would have left but a faint impress upon the nations who owned her sovereignty. The long reign of law and order, from which we derive the chief legacies which Rome has left to the modern world, was yet to come. That the newly-founded empire did not fall before the onslaught of an eastern despot, or break up into separate provinces governed by rebellious citizens, is due, as far as we can see, to Julius Cæsar alone. It is difficult to see how such a man could have been produced by the wants of any age, but there is no doubt that the course of future history was marked out in no slight degree by the genius and foresight of this single individual.

Cæsar displayed at the very outset of his career the same versatility, energy, and courage which distinguished him till its close. When ordered by Sulla to put away his wife, who was connected with the Marian party, he refused to obey, although he lost by the refusal his wife's dower, his priesthood, and his fortune. Although compelled to quit Rome to avoid the dictator's anger, he did not deprive his country of his services. His diplomacy served to obtain from Nicomedes, king of Bithynia, a fleet, which was used in the reduction of Mitylene, and by his personal bravery in the siege he won from Marcus Thermus the reward of a civic crown. He served in Cilicia against the pirates, whose extinction was to be the great glory of his rival, and either at this or at a later time (for authorities differ on this point) had an adventure with them, which displays his subtlety and resource. Taken prisoner by them at the island of Pharmacussa he sent the main body of his companions and attendants to seek his ransom. During his stay of forty days, he ingratiated himself with his captors, and promised them in jest that when once set free he would return and crucify them, and he kept his word. When he was released he armed some vessels of Miletus, found the pirates in the anchorage where he had left them, took them into Pergamus, and handed them over to the civil arm. When a student under Apollonius Molo at Rhodes, on the outbreak of the Mithridatic war, he passed, of his own accord, to the continent, drove the king's general from the province, and restored the shaken allegiance of the subject towns. A Roman citizen of birth was expected not only to be a general and a statesman but an orator. He must be practised in every branch of the art of government. Cæsar attained distinction in the forum with the same ease as he had won it in the field. He accused Dolabella of extortion in the provinces in 77 B.C., and Antonius of a similar offence in 76 B.C. In neither prosecution was he successful, but he gained in both a reputation for eloquence and public spirit. To perfect himself in oratory he sought the instruction of Apollonius before mentioned, under whom Cicero had also studied, and who had striven with little success to curb the extravagance of his redundant diction. Perhaps it is to him that we owe the massive and monumental eloquence, the pure and chastened taste of the *Commentaries*. The chronology of these events is uncertain, but in 74 B.C. Cæsar returned to Rome, and was elected pontiff and military tribune. Not untried in war and in affairs, tinged with Greek culture but not weakened by it, in the prime of youth and the fulness of fascination, he was fitted in every way to gain the favour of his countrymen, and to play his part in the game of politics, which required then, if ever, an open brow and secret thoughts.

For the next twelve years Cæsar, with the exception of a short absence in Spain as quæstor, remained at Rome. During the whole of this time he lent his assistance to the task of strengthening and reviving the democratic party, which had sunk very low after the death of Marius. He was thus brought constantly into connection with Pompeius, and it is difficult for us to determine whether Cæsar supported Pompeius because he perceived that his ends were those which he himself wished to gain, or whether Pompeius courted the democratic party for the purpose of his own aggrandizement. In 70 B.C. Pompeius, in conjunction with Crassus, repealed the Sullan constitution, and in the measures which were necessary for this purpose he had the full approval and support of Cæsar. The power of the tribunes was restored, that of the senate diminished. The control of the law courts, which Sulla had given back to the senate, and which had been abused to shield from punishment high-born plunderers of the provinces, was now divided among the senate, the equites, who were the great capitalists, and the tribuni ærarii, who represented a still more popular element. Cæsar in this conduct was true to the principles which animated his whole career, a desire to give equality to the citizens, and recognition to the subjects of Rome, and to obliterate as far as possible the scars of civil dissension. In 68 B.C. he lost his aunt and his wife, one the widow of Marius, the other the daughter of Cinna. In the orations which he pronounced over them in the forum, he was able to rehabilitate the reputation of the leaders of his party. At his aunt's funeral he caused busts of Marius to be carried in the procession, and the people were roused to recall at once the greatness of their general, whose memory had been so long proscribed, and the generous courage of his kinsman in restoring it. As the power of the senate became weakened, respect for the old safeguards of the constitution became less strong. It was therefore not unnatural, when Rome was suffering from the attacks of enemies whom she could not quell, that she should invest her former general with an extraordinary command, and seek in new expedients a remedy which the constitution had failed to supply. Such was the origin of the Gabinian and Manilian laws, the first of which conferred on Pompeius a command against the pirates of the Mediterranean, while the second gave him control of the Mithridatic war. Never had such power been concentrated in the hands of a single citizen. He was invested with absolute control for three years over the whole

of the Mediterranean Sea, from the Straits of Gibraltar to the innermost bays of the Levant, and over the coasts for fifty miles inland. Under him were twenty-five prætors of senatorial rank chosen by himself. He had ample authority for levying troops and raising money. By the Manilian law he obtained in addition command over the whole of the East, "so that there remained scarcely a spot of land within the wide Roman dominions that had not obeyed him." These laws were opposed by the friends of the senate and by those who still cherished respect for the old constitution of the city. They were supported by Cæsar and by Cicero, and were carried by the public voice. We need not see in this action of Cæsar's a desire either to get rid of Pompeius as a rival, or to earn future favour by present support; we may rather conclude that he saw more clearly than the statesmen of his time the growth of a new order and the decay of the old, and the necessity of fresh and even perilous expedients to meet wants which had not before arisen.

After the departure of Pompeius, Cæsar held the ædileship with Bibulus. His business in this office was to take charge of the public buildings, to repair the old, to furnish such new ones as were required, and to keep the multitude in good temper by a due magnificence in their national games. This office was to Cæsar the occasion of fresh triumphs. Bibulus supplied the money, but Cæsar showed how it might best be spent, and gained the whole credit of the generosity displayed. He decorated the forum,—that small space under the Capitoline hill, on which every successive master of Rome has for good or for evil left his mark. He built, either at this or at a later time, the basilica Julia, which has again come to light in our generation, the first of those imperial erections which were imitated by his successors, and which extended the long line of colonnades and halls of justice far beyond the narrow limits of the Septimontium. He built porticoes under the Capitol for the reception of works of art, the plunder of Grecian cities; and he struck a deeper chord in the hearts of his countrymen when by his order the trophies won by Marius from barbaric kings and peoples glittered one morning freshly adorned and gilded in the place from which they had been removed by Sulla. The defenceless city was terrified at the number of gladiators which he proposed to exhibit in the Great Games, and restricted him to three hundred and twenty pairs, but he made amends by arming them with accoutrements of silver, an act of magnificence remembered even in times when the city was sated with profusion.

In the following year, 64 B.C., he was concerned in measures which show the consistency of his political character. He supported the agrarian law of Rullus (which, as far as we know its provisions, proposed to settle the poorer citizens in the waste lands of Campania and elsewhere), because, although its provisions might be defective, its principles were good, and calculated to lessen the inequality between the different members of the state. Cicero may, with the responsibility which attached to him as consul, have been right in procuring its rejection as ill-digested and premature. Cæsar's support of the impeachment of Rabirius for the murder of Saturninus thirty-seven years before, was perhaps intended to show that party feeling should never be suffered to cover the commission of a crime, to assert again the principles of democracy which had been long unpopular, and also to deter young aristocrats from imitating the excesses of Sulla. These principles once asserted, there was no need to carry the prosecution to extremities. In the year following, 63 B.C., he was elected Pontifex Maximus, a signal mark of his popularity. This office placed him at the head of the state religion. Although he did not obtain it without bribery, yet we cannot believe that he would have been elected unless the people had felt confidence in the dignity and integrity of his character, and if he had been the frivolous and abandoned libertine which some historians represent him to have been at this time. De Quincey has remarked that we are presented with a touching picture of his home life on the morning of his candidature. His mother Aurelia accompanied him to the portico of the house, with a mingled feeling of hope for his success and fear for his safety, and he answered to her expressed anxieties that he would return a conqueror or a corpse. We may believe that to his mother he owed many of his most commanding qualities. Throughout her life he treated her with deep affection and respect, and we have abundant proof that Cæsar possessed to the full that strong family affection which always accompanies a noble nature, and which the Romans of that day have by some writers been so strangely supposed to have been without.

An event was at hand of sufficient seriousness to try the mettle of the strongest. The conspiracy of Catiline has perhaps been exaggerated by the vanity of Cicero; but allowing for this exaggeration, it threatened serious danger to the state, and it affords a conclusive proof of the impotence of the Roman government at this time. We shall find the closest parallel in the military pronunciamientos of modern Spain. Catiline had probably little design beyond obtaining the best places of government for himself and his friends at any cost. If Cæsar had joined this movement he might have mastered it and directed it to his own purposes; had he been an unprincipled adventurer he might have framed for himself combinations more likely to succeed. There is no proof that Cæsar was an accomplice in this villany. Probability is against it. What we do know is that on December 5th he spoke against the execution of the conspirators. In this we have evidence of his strong common sense and political foresight. He saw that it was bad policy to break the laws in order to punish their violation. He knew also that the dead alone come back to haunt the living. "If an adequate punishment," he said, "can be devised for these men's offences let it be inflicted; if their offence transcends all punishment, let us punish them by the laws of our country." It would have been well for Cicero if he had followed this advice. Such language was thoroughly consistent in the mouth of a man who had done his best to remedy the excesses of Sulla, from which he himself had suffered, and who had lost no opportunity of inculcating political moderation. The next year, 62 B.C., Cæsar was prætor. At the close of it Pompeius returned from the conquest of Mithridates, and quietly disbanded his army. The time had not arrived for Cæsar to lay aside the toga. In 61 B.C., at the age of forty, he assumed as proprætor his first important military command, and laid the foundation of a reputation as the greatest of generals, which should never be allowed to overshadow his higher merit as a statesman and the regenerator of his country.

Before Cæsar could leave Rome for his province it was necessary that he should clear himself from the load of debt which oppressed him, and this he was enabled to do by the assistance of Crassus. A charge of insolvency has been allowed to weigh too heavily upon the character of Cæsar, and has received too much importance as a motive for his actions. It can be accounted for by supposing an over-recklessness of means to gain important public ends, and a culpable carelessness in his private interests, which are not without a parallel in statesmen of modern times, whose character is above suspicion. We have little positive information about his campaign in the Peninsula, the main operations of which were carried on in Galicia and Portugal. Cæsar appears to have exhibited on a small field the same qualities which distinguished him in a large sphere. He was proclaimed imperator by his soldiers, was voted a

triumph by the senate, and while he added to the riches of the state, was careful to render his own fortune more secure. He was a candidate for the consulship in the following year, and would gladly have conducted his canvass by proxy, while he kept his army outside the gates in readiness for his promised triumph. But Cato and the senate would not permit this violation of the law. Cæsar at once obeyed, surrendered his triumph, and obtained the consulship. He formed at this time an alliance with Pompeius and Crassus, which is generally known as the first triumvirate. It was merely a political union for common purposes, and was not, like the second triumvirate, an organized form of government. Pompeius and Crassus had been enemies, and were now reconciled by Cæsar. Cato, the champion of the senate, could not be included in this alliance, and Cicero was too vacillating in his policy and too weak in character to command the confidence of either of his former friends. The objects of the coalition were not so much to secure the personal aggrandizement of its members, as to form a strong and united front against those who wished to maintain a form of government which had become impossible, and was therefore hurtful to the state. It is possible that both Pompeius and Cæsar foresaw that under a new constitution Rome would be subject to a single head, while Crassus was not reluctant to join himself to two men, one of whom must be the ruler of the future. The democracy which raised Cæsar to power wished to obtain for its favourite the command of an army which would ensure the preponderance of his counsel in coming changes. Cæsar himself, conscious of the pressing need of important measures, and the inability of the senate to provide them, was ready with the frankest generosity to work with any one whose ideas were on this point coincident with his own. The alliance was cemented by the marriage of Pompeius to Julia, Cæsar's daughter, while Cæsar married Calpurnia, the daughter of Piso.

Cæsar's colleague in the consulship was M. Bibulus, the devoted servant of the senate, who both as ædile and prætor had submitted as a foil to set off the greatness of his companion. He offered a vain opposition to Cæsar's measures, and when he found that he could not prevent their being carried by the use of the political machinery in his power, he retired to his house and announced his intention of "observing the heavens" during the rest of his consulship, a process which ought technically to have rendered invalid all acts passed during that time. We do not possess a full account of the laws carried by Cæsar while he stood at the head of the state, but we know enough to show us that he used his opportunities to enforce the same political principles which he had always consistently professed. He ordered the proceedings of the senate to be published, and so rendered its deliberations amenable to public opinion. He passed an agrarian law similar to that of Rullus, but without the defects which had procured its rejection. He carried a measure of just relief for the *equites* or capitalists, not so much with a view of gaining their support as to make a fair concession to an important class of the community. He declared Ptolemy, king of Egypt, and Ariovistus, the German, friends of the Roman people. He made regulations for the better government of the provinces, and remedied the worst abuses under which the provinces groaned. He was the author of a great measure for the suppression of bribery and corruption amongst public functionaries, which were at that time a stigma on the state. Other resources of a similar tendency were carried by his subordinates. The senate had intended that Cæsar, on laying down his office, should be rendered as harmless as possible, and for that reason had assigned to the consuls the charge of woods and forests in Italy. The people, however, were able to protest successfully against the injustice. The tribune Vatinius obtained the passing of a law which gave to Cæsar the province of Cisalpine Gaul or Northern Italy for five years, with three legions; and the senate of its own accord added the charge of Gaul and the Alps with an additional legion. Cæsar thus obtained a field of action worthy of his genius. He stayed near the city just long enough to secure the election of his friends as consuls, and to provide against the repeal of the measures which he had passed, and then set out for the country which has ever since been identified with his name.

It is not our object to describe in detail the marvellous work which occupied Cæsar for the next eight years. No part of his life has been written with greater fulness, nor is there any for which we possess more abundant material. It must suffice to give a short sketch of the masterly campaigns by which a free and chivalrous people were reduced to absolute obedience, new countries were opened up to the knowledge and enterprize of Rome, and a form was given to the development of the civilization of France, of which she has preserved the main features to the present day. In his first campaign (58 B.C.) Cæsar gained two important victories. He defeated at Autun the Helvetii who were leaving Switzerland with the intention of settling themselves on the fertile seaboard of the Atlantic, and forced the greater number of them to return to the homes which they had left. He attacked a nobler foe in the Germans under Ariovistus, the friend of the Roman people, and in the neighbourhood of Mühlhausen cut them to pieces, and drove the few survivors across the Rhine. This mighty stream now became the boundary of the Roman empire. All central Gaul was quelled by his bold attack, and the Germans were cowed into quietude, but the Belgæ, a mixed race of warlike qualities, remained unsubdued. In the next year (57 B.C.) Cæsar marched against them, and scattered their confederacy to the winds. The Nervii made a better stand, and Cæsar was forced to expose his life, and to fight like a common soldier. But they, too, sustained a crushing defeat, and the submission of the Veneti and the coast cantons to Publius Crassus left only the northern tribes, such as the Morini and Menapii, independent of the Roman rule. The work of Crassus had been imperfectly performed, and in the following year (56 B.C.) the Veneti threw off the yoke. The whole coast from the Loire to the Rhine joined the insurrection. Cæsar hurried from Italy, and taking measures for the security of the north and south, prepared to attack the Veneti by sea. Victorious by sea as by land by new and skilful devices, he disabled their powerful fleet, and sold the defeated captives into slavery to a man. The Morini and Menapii alone remained unconquered, protected more than any thing else by the natural strength of their country. Cæsar marched against them, but was forced to desist from the attack. With this exception, the whole of Gaul had been reduced to obedience in three campaigns. Cæsar now turned his arms against the Germans. He cut to pieces the Usipetes and Tenchteri, who had crossed the lower Rhine, after treacherously depriving them of their leaders, who had come of their own free will into his camp. There is no excuse for this violation of international law, which was very properly rebuked by Cato in the senate; but Cæsar might have replied that the precedents of Roman history had not inculcated a spirit of fairness or forbearance towards alien enemies. He built a bridge across the Rhine, and remained eighteen days on the other bank. The same year (55 B.C.) witnessed his first expedition to Britain, whither he was led partly from curiosity, and partly by a desire to detach from the Celtic confederacy a land which was the sure asylum of political refugees. The islanders made a brave resistance, and Cæsar was compelled to retreat. He

was so much dissatisfied with the result of the campaign, that he made great preparations for renewing the attack in 54 B.C. On this occasion he penetrated further into the interior and crossed the Thames, but Cassivellaunus, to whom the defence of his country had been entrusted, followed the Roman army with his war chariots, and successfully impeded their operations. Cæsar, before he left, imposed a tribute and demanded hostages, but it was difficult to conceal that he retired discomfited from a land which he had to all appearance seriously intended to subdue. The next two years witnessed the final struggle of the Gauls to regain their freedom. Inspirited by the resistance of the Germans and the Britons, and inflamed by the death of Dumnorix, they determined to make a simultaneous attack on the Roman garrisons, which this winter were scattered more widely than usual. Q. Titurius Sabinus and L. Aurelius Cotta were the first assailed. Deceived by Ambiorix, king of the Eburones, their whole division was annihilated. A similar attack was made upon Q. Cicero in the territory of the Nervii, but Cæsar was near enough to bring assistance. The insurrection was checked and a terrible vengeance exacted from the Eburones. Acco, prince of the Carnutes, was executed by the victors. His death spurred his tribesmen to greater exertions. In the winter of 53–52 B.C. they roused the spirit of their countrymen. The post of honour was held by the Arverni, under their prince Vercingetorix, an heroic leader, whose name casts lustre on this last vigorous but hopeless struggle. A new plan of defence was adopted. Instead of defending every town against the Romans, it was determined to burn those places which could not be held, and to concentrate their forces in those strong positions which gave a good hope of success. Thus the campaign clusters round the names of Avaricum, Gergovia, and Alesia. The first of these towns (Bourges) was taken in the spring of 52 B.C. The second, the capital of the Arverni, was attacked by Cæsar in vain, and an attempt to remedy the disaster led to a more decisive defeat. The star of Cæsar began to pale. The Hædui, who had before hesitated to join the insurrection, now avowed their hostility, and the whole nation rose like one man to cast off the yoke of the invader. The final struggle was concentrated round the hill-town of Alesia. Vercingetorix, faithful to his tactics, took refuge here with 80,000 infantry and 25,000 horse. Cæsar had been able to join his forces with Labienus, and invested the hill on every side. The mighty masses of the Gallic landsturm crowded from all quarters to release their champion. Cæsar was at once besieger and besieged. In this supreme crisis his genius triumphed. The provisions of Alesia were exhausted. Cæsar repulsed the double attack on both his lines, and Vercingetorix, disdaining to fly, delivered himself into the power of his conqueror. Had the result been otherwise, it is possible that Cæsar might have been driven from Gaul, and the floods of barbarians pouring down over Italy would have anticipated history by five hundred years. The following year (51 B.C.) saw the final pacification of the country. In eight years Cæsar had done his work most thoroughly. Gaul never afterwards attempted to revolt, but remained a rich and contented member of the Roman empire. On no subject-country was impressed more completely the language, laws, and civilization of its masters. If it had been possible so gradually to extend the bounds of Roman dominion as to convert dangerous hordes of undisciplined tribes into contented allies, Cæsar shows us how it might have been done. Even the patriotism of an emperor of the French cannot but admit that it was better for his country that Cæsar should conquer than Vercingetorix.

Whilst Cæsar had been engaged in the conquest of Gaul, the bands which held the triumvirate together had gradually become loosened. The three members of the coalition had met at Lucca in 56 B.C., and had arranged that Cæsar's command in Gaul should be continued for another five years; that Pompeius and Crassus should be elected consuls for 55 B.C.; and that on the expiration of their office Crassus should have Syria for his province and Pompeius the two Spains. These arrangements were carried out, but in September 54 B.C. Julia, the daughter of Cæsar and the wife of Pompeius, died. A project for a double alliance of a similar kind was rejected by Pompeius. In 53 B.C. Crassus was slain in Parthia. In 52 B.C. it became clear that Pompeius was asserting his independence, was drawing nearer to Cato as an ally, and was becoming more disposed to act as the champion of the senate. From this time till the outbreak of the civil war, it was more and more evident that a collision between the two great rivals was inevitable, although Cæsar did his best to avert the catastrophe. The details of the final quarrel are complicated and difficult to understand. By the law of Vatinius Cæsar's command expired in 54 B.C., by that of Trebonius it was continued till 49 B.C. It is comparatively unimportant whether his *imperium* would determine at the end of February or the end of December in that year. It had been arranged among the triumvirs that Cæsar should be consul in 48 B.C. According to strict Roman law he must announce himself personally as a candidate, which he could not do whilst he was still in command of an army. Pompeius had, in 52 B.C., secured to Cæsar exemption from the restriction by a tribunician law, but there was some doubt whether this had not been rendered invalid by a subsequent enactment. In the same year it had been decreed that no one should hold a governorship until five years had elapsed from his laying down the office of consul or senator. In 51 B.C. the question of appointing a successor to Cæsar came before the senate, and it was finally determined that his command should come to an end on the Ides of November, 49 B.C. The object of the senate was that some interval should elapse between Cæsar's consulship and proconsulship. Cæsar knew that he could not trust himself to the power of his enemies, but he displayed his usual moderation. He gave up the two legions which were demanded from him for the Parthian war, and by means of Curio, whom he had won over to his side, he proposed to the senate that Pompeius and himself should simultaneously disarm. To the surprise of the aristocratic party the motion was carried. Marcellus refused to accept the decision on the plea that Cæsar was bringing his army into Northern Italy. He called on Pompeius to put himself at the head of the legion in Campania, and declare war against the invader. Cæsar made one more ineffectual attempt at compromise. The propositions brought by Curio to the new consuls on January 1, 49 B.C., were contemptuously rejected, and Cæsar was peremptorily ordered to resign his command. Although he had only one legion with him at Ravenna he could not hesitate. He crossed the frontier of Italy, and arrived at Ariminum.

Cæsar crossed the Rubicon in the middle of January, 49 B.C., and he was murdered on the Ides of March, 44 B.C. During this space of a little over five years he crushed in every part of Europe the armies of his enemies, and laid deep and strong the foundations of the imperial power of his successors. He spent barely fifteen months of this time in Rome. He did not now, as his enemies had expected, march at once upon the capital. He observed that a surer way lay open to him of securing the possession of Italy by seizing the central heart of the peninsula, which in ancient as in modern times has held out delusive hopes to patriot people and rebellious kings of taming the proud tyranny of the Tiber city. Here the solitary church of St Pelino marks the site of Corfinium, once the destined home

of Latin independence, and the city of Aquila languishes under the snows of the Gran Sasso d'Italia, a monument of the vain but chivalrous struggle of the emperors against the popes. Into these upland valleys, lying midway between the two seas, Cæsar dashed with irresistible force, and town after town fell before him and his lieutenants. Pompeius moved slowly towards Brundusium, whither he was followed by the conqueror. Cæsar was unable to prevent the embarkation of his troops for Greece, but when by the end of March he reached Rome he was already the undisputed master of Italy.

In his next operations Cæsar displayed to a marvellous degree his ability and resources, and showed how the success of his projects depended entirely upon his personal exertions. His lieutenants were seldom fortunate; but, like Napoleon, his presence was worth an army, and, like Frederick the Great, he knew how to spring at once from the deepest embarrassments to the triumph of victory. At Ilerda his army was cooped up between two rivers, and all communication with Rome cut off. By a clever stratagem he surrounded Afranius and Petreius, and compelled them to surrender. At Dyrrachium he was in a worse position, encamped on a barren ridge, encompassed by a far superior army on the land side, and cut off from the sea, which was in the power of his enemies. Even when he had received his reinforcements he could not hold his own against greater numbers. Yet he was able to take advantage of the first mistake of Pompeius, and the victory of Pharsalus was crushing and complete. At Alexandria, where his stay is difficult to account for even by the attractions of Cleopatra, he nearly fell a victim to a popular tumult, yet he was no sooner extricated from his difficulties than he marched into Asia, saw and conquered the son of the great Mithridates, and placed the affairs of the East on a basis of security. In Africa he had allowed the Pompeians to attain a dangerous efficiency of organization by his delay at Alexandria, and it was only through the extremest caution that he was enabled to assemble his tardy forces. But the battle of Thapsus deprived the senate of their last and noblest champion, and left Cæsar the master of the Roman world. The capitulation of Ilerda took place in August 49 B.C., the winter of 49–48 B.C. was passed on the coast of Illyria, the battle of Pharsalus was fought on August 9, 48 B.C., and Pharnaces was defeated at Zela on August 2, 47 B.C. Cæsar's stay at Rome was chequered by the mutiny of the legions in Campania, and the difficulty of assembling his troops; yet he was able to land in Africa before the end of 47 B.C., and he won the victory of Thapsus on April 6, 46 B.C. In July of that year he entered Rome as conqueror, and could now find leisure to govern the world which he had subdued.

During four separate days he celebrated four triumphs over Gaul, Egypt, Pontus, and Africa. Vercingetorix, who struggled in vain to save his country, Arsinoe the sister of Cleopatra, and the son of Juba, king of Mauretania, followed his triumphal car. The citizens were publicly feasted at the dictator's expense, a distribution of money was made to the poor and the strange magnificence of the games celebrated in memory of his daughter Julia fulfilled the promise of the splendour of his ædileship. One more struggle was necessary before peace was finally secured. The sons of Pompeius, Cnæus and Sextus, had collected a large army in Spain, which had always been the stronghold of their cause. The battle of Munda, fought on March 17, 45 B.C., resulted in their entire defeat, but Cæsar was compelled to be absent from the capital from the end of 46 B.C. till September 45 B.C.

It may be questioned whether Cæsar was himself anxious to receive the title of king, which his admirers were without doubt desirous to force upon him. Such a title would have added but little to his real power over every department of the state. After the expulsion of the kings the Roman constitution came eventually into such a form that, while every interest was represented, the whole power could never come into the hands of one individual. The two consuls were a check upon each other, and they were themselves subordinate to the senate. The tribunes occupied an entirely different position to the other magistrates, and defended the interests of the mass of the citizens. The senate itself was controlled by the censor, and the working of the political machine was so ordered that a single magistrate could, either by his personal objection, or by a skilful use of divine sanctions, obstruct any measure of a rash or unusual character. The chief officers of the state were occasionally suspended by the appointment of a dictator for extraordinary emergencies, but it had probably never occurred to any statesman that the whole of these well-balanced and often conflicting authorities might come to be concentrated in the person of one man. Yet it was by these means that the republic became a monarchy, and that Cæsar became emperor. He was five times consul and four times dictator, and at his death was dictator elect for life. He had the tribunician power conferred upon him, which, among other advantages, rendered his person inviolable. Instead of the censorship he was invested with the new office of *præfectus morum*, which he used to curb the luxury and extravagance induced by the influx of conquered wealth. His opinion was, as *princeps senatus*, asked first in the senate; his effigy was struck upon the coins. The exaggerated and half-divine honours which the servility of the senate invested added but little to his power, but the title of *imperator*, with which many a successful general had been saluted on the field of battle, was now *prefixed* to his name as a permanent addition, and has remained, together with the family name of him who first bore it, as the title of highest sovereignty throughout the civilized world.

The complex of authorities thus placed in his hands he used in a manner to justify the confidence of those who entrusted them to him. It is difficult to give an accurate account of his administration. Mommsen, in the brilliant chapter which at present closes his history of Rome, has scarcely distinguished with sufficient care between Cæsar's intentions and his acts, and between his measures and those of his successors. Yet we have ample evidence that much was done and much more conceived. If we follow the authority of Suetonius we find that he reformed the calendar by intercalating three months in the year 46, and making arrangements for the future, which lasted unchanged till the 16th century. He increased the number of the senate to nine hundred, and made it more thoroughly representative of all classes and all parts of the empire. He increased the number of the magistrates, did his best to heal the wounds left by the civil war, and reformed the courts of justice. He confined donations of corn to the poorer citizens, and while by the rebuilding of Carthage and Corinth he found a refuge for many who would have starved at home, he did his best to prohibit absenteeism, and to discourage the tillage of the soil of Italy by slaves. He gave the rights of citizenship to men of science and to professors of liberal arts, enforced the laws without favour, and attempted with little success to restrain the luxury of the age. He prepared the way for the work of his successor, who found Rome of brick and left it of marble. He intended to codify the law, and to provide public libraries of Greek and Latin works, the care of which he entrusted to Varro, the most learned of the Romans. He is credited with the design of draining the Pontine marshes, a work yet to be performed; of converting the Fucine lake into a fertile plain, an enterprise begun by Claudius and completed by Prince Torlonia; of

piercing the isthmus of Corinth; of making a road from the Adriatic to the Tiber; and further, of subduing the Parthians, and returning through Scythia and Germany into Italy, after extending the limits of the empire to the stream of the ocean.

However this may be, it is certain that at the time of his death he was preparing an expedition against the Parthians. It is useless to speculate whether his absence from the city would have been short or long. There is evidence that he did not feel at his ease in the capital, that he considered his personal work to be accomplished, and that his plans could be better carried out by his successor. Yet nothing can excuse the shortsighted wickedness and folly of those who murdered him. We need not repeat the well-known story, how in the Ides of March, 44 B.C., Cæsar was murdered in a meeting of the senate, and fell at the feet of the statue of Pompeius, pierced with wounds from head to foot, only one of which was fatal. There is no reason to believe that the conspiracy had been long in preparation, or that it was motived on the one hand by a desire for personal aggrandizement, or still less, on the other, by a devoted patriotism. It began in spite, and continued in folly. A very slight degree of political foresight might have convinced those who assented to the plot that the people would not be on their side, and that they would precipitate the very conclusion which they desired to avert. Those who deified Brutus in the French Revolution knew but little of Roman history, or confounded him with the expeller of the Tarquins. Dante is a better judge, whose ardent love of liberty did not blind him to the necessity of a strong and united government for his native land. The divine poet relates to us with an appalling realism, that in the centre of the earth, in the bottom of the pit of hell, Lucifer holds in his three mouths the three greatest malefactors the world has ever seen,—Brutus and Cassius, who betrayed their sovereign and their country, and Judas Iscariot, who betrayed his Master with a kiss.

Under different circumstances Cæsar might have won as great a reputation as a man of letters as he has acquired as a general and a statesman. He was fully aware that a change in the literary language of his countrymen was as necessary as in their government and constitution. The rude though vigorous dialect of Plautus, or even of Varro, was not suited to be the organ of civilization throughout a subject world. A widespread knowledge of Greek had made the Romans aware of their own deficiencies, and the united efforts of all men of culture to give form and refinement to the Latin tongue culminated in the glories of the Augustan age. Cicero and Livy, Virgil and Horace, have remained as examples of Latin style during the whole of the Christian era. The language in which they wrote must have differed widely from anything which was spoken by their most cultivated contemporaries. It is not unreasonable to feel some regret that the cultivated language did not follow a course of development more suited to its inherent character, and that Lucretius and Cæsar were not adopted by the rhetoricians of the empire as models for precept and imitation. The excellence of the Latin language lies in its solidity and precision; its defects lie in a want of lightness and flexibility. Lucretius found it sufficient to express with admirable clearness very complex philosophical reasoning, and Cæsar exhibited its excellencies in their purest and chastest form. It is a misfortune that the *Commentaries* are not more often studied as a masterpiece of literature, but are relegated by the irony of fortune to the lower forms of schools. Their style is faultless, not a word is thrown away or used with a doubtful meaning, every expression is in its place, and each touch serves to enhance the effect of the whole. Had Cæsar been writing history instead of military memoirs, he might have allowed himself greater freedom of ornament. We know, from his treatise on grammar (*De Analogia*), often quoted by grammarians, that his success in literature was the result of careful study and meditation. As an orator he was acknowledged to be second to Cicero alone, and he is one of the few men in history who have quelled a rebellion by a speech.

In this sketch of Cæsar's life we have found but little to blame, and have been able to add few shadows to the picture. The stories which the jealousy of contemporaries have preserved against him are too frivolous to be recorded, while the dignity, sweetness, and nobleness of his character cannot be concealed. We have preferred rather to attempt to construct from very imperfect materials some faint resemblance of the marvellous personality of him whom the genius of Shakespeare rightly recognized as "the foremost man of all this world."

The principal ancient authorities for the life of Cæsar are the biographies of Plutarch and Suetonius, the letters and orations of Cicero, and the Commentaries on the Gallic and Civil Wars written by or ascribed to Cæsar himself. To these may be added Appian's *Civil War*, Dion Cassius, Velleius Paterculus, Sallust's *Catiline*, the *Epitomes* of Livy, and Lucan's *Pharsalia*. His life has been perpetually narrated in ancient and modern times, and has been the battle-field of imperialists and republicans. For English readers, the account given by Merivale, both in his *History of the Romans under the Empire*, and in the *Fall of the Roman Republic*, is readable and adequate; the fullest and fairest examination of the original authorities is in Long's *Decline of the Roman Republic*, vols. iii.–v. The article in Smith's *Biographical Dictionary* is excellent, but by far the most brilliant picture of Cæsar's character and work is to be found in Mommsen's *History of Rome* (published 1856, translated into English 1866). Mommsen is extremely favourable to Cæsar, but unfair to his opponents. The *Histoire de César* of Napoleon III., which extends only to the outbreak of the civil war, is especially valuable from the maps and plans which accompany it. The German student will find a full and satisfactory repertory of all that is known about the subject in Drumann, *Geschichte Roms*. (O. B.)

CÆSAR, Sir Julius (1557–1636), a learned civilian, descended by the female line from the Dukes de' Cesarini in Italy, was born near Tottenham in Middlesex. He was educated at Oxford, and afterwards studied at the university of Paris, where in the year 1581 he was created doctor of the civil law. Two years later he was admitted to the same degree at Oxford, and also became doctor of the canon law. He held many high offices during the reigns of Elizabeth and James I., and for the last twenty years of his life was master of the rolls. He was so remarkable for his bounty and charity to all persons of worth, that it was said of him that he seemed to be the almoner-general of the nation. His manuscripts, many of which are now in the British Museum, were sold by auction in 1757 for upwards of £500. See E. Lodge, *Life of Sir Julius Cæsar*, 1810.

CÆSAREA, the name of two towns in Palestine:—

I. Cæsarea Palestina, now Kaisaryah, the Roman metropolis of Palestine, 30 miles north of Joppa, and about the same distance north-west of Jerusalem. It was built about 22 B.C. by Herod, on the site of an earlier town called Turris Stratonis. Vast sums of money were spent in the erection of its more important buildings, among which were a temple dedicated to Cæsar, a theatre, and an amphitheatre. The most stupendous work, however, was the semicircular mole, constructed of immense blocks of stone brought from a great distance, and sunk to the depth of twenty fathoms in the sea. It protected the port on the south and west, leaving only a sufficient opening for vessels to enter from the north, so that within the enclosed space (which, according to Lieutenant Conder, measures 300 yards across) a fleet might ride in all weathers in perfect security. The site of the city is now marked by an extensive mass of ruins, among which may still be traced the substructions of all the above-mentioned buildings, as well as those of

the cathedral built by the Crusaders, an old fortress on the site, it is supposed, of Herod's "Drusus tower," two aqueducts, and a variety of minor structures. The line of the walls of the mediæval town can still be made out, and in some parts that of the more extensive Roman works. The southern part of the mole is also intact. Cæsarea was made the seat of a colony by Vespasian, and took for a time the title of Flavia, but its earlier name was maintained to the time of its complete decay. In the 4th century it was the see of Eusebius, the church historian, and during the crusading period was one of the chief posts of the invaders.

II. Cæsarea Philippi, 95 miles north of Jerusalem, and about 35 south-west of Damascus, situated at the southern base of Mount Hermon, near one of the sources of the Jordan. It has been identified with Baalgad or Beth-Rehob, and was certainly known for a long time as Panium or Panias, the cave at the foot of the mountain being dedicated to Pan. Herod erected a temple to Augustus in the neighbourhood; and the town was much enlarged and beautified by Philip the Tetrarch, who named it Cæsarea in honour of Tiberius the emperor, adding the cognomen of Philippi to distinguish it from the town last noticed. It continued to be a place of some importance till after the time of the Crusades, and was successively the seat of a Greek and a Latin bishopric. Its site is occupied by the modern Bâniâs or Panias, a paltry and insignificant village, with numerous ruins in the vicinity. On the top of a conical hill above the village stands the castle of Subeibeh, which possibly dates from the time of the Phœnicians, and has been one of the most remarkable fortresses in Palestine from that day to this.

CÆSAREA, or Kaisarieh, a city in Asiatic Turkey, formerly one of the most important places in Cappadocia, and at present the chief town of a sanjak in the province of Karaman, situated on the Kara-su, between two spurs of the Mons Argæus, in 38° 42′ N. lat. and 35° 20′ E. long. It is the seat of an Armenian bishop, and the commercial centre of an extensive and highly populous district; its markets are well supplied with European goods, and its inhabitants noted for their enterprise. Its principal manufactures are cotton and morocco leather. Recently it has become the scene of a considerable Protestant movement, and a girls' school, the first in the city, has been established. The ruins of an earlier Mahometan town are immediately contiguous, and a little to the south are the ruins of the ancient city. The latter was known originally as Mazaca, and afterwards as Eusebia; and only received its present name from the Emperor Tiberius. It was for a time the seat of the Cappadocian kings; but it suffered greatly at the hands of Tigranes, who carried off its inhabitants to his new city of Tigranocerta. Under the later Roman empire it recovered to such an extent that it was supposed to contain 400,000 inhabitants when it was captured by Sapor in the reign of Valerian. The present population, of which about two-thirds are Turks and the rest mainly Armenians and Greeks, is estimated at about 10,000.

CAFFRARIA See Africa (vol. i. p. 263) and Kaffraria.

CAGLI (the ancient *Calles*), a walled town of Italy, in the province of Pesaro e Urbino, at the confluence of the Cantiano and Busso, the former of which is crossed there by an ancient Roman bridge. It is the seat of a bishop, and has a cathedral and several churches and monasteries, in one of which, Santo Domenico, is preserved a famous fresco by Giovanni Santi, the father of Raffaelle. The principal occupation of the town is the manufacture of leather. Population 10,213.

CAGLIARI, the capital of the island of Sardinia, and chief town of its southern province, is situated in the recess of the bay to which it gives its name, not far from the mouth of the River Mulargia, in 39° 33′ 14″ N. lat. and 9° 7′ 48″ E. long. It has a splendid appearance from the sea, occupying as it does the slope and summit of a hill, which is crowned by a noble castle. This building gives the name of Castello, or, in Sardinian, Casteddu, to the district containing the vice-regal palace, the cathedral, the university, the theatre, the chief mansions of the nobility, and the public seminaries. To the west of the Castello lies the district of Stampace, with the Corso, and to the east that of Villanuova with its pleasant promenades,—both consisting for the most part of narrow, irregular, and ill-paved streets, but the former inhabited by the wealthier citizens. The slope between the castle and the bay is occupied by the Marina, a well-built quarter, containing the residences of the merchants and consuls, the bonded warehouses, and the lazaretto; while to the west of the town is the spacious suburb of St Avandrace, nearly a mile in length. The university, which possesses the four faculties of theology, law, medicine, and arts, was founded in 1596 by Philip of Spain, was restored in 1720, and was remodelled in 1764. It has a library of upwards of 22,000 volumes, and numbers from 100 to 200 students. Besides the cathedral, which was built by the Pisans during the 14th century (though the present front only dates from 1703), Cagliari contains about thirty churches and twenty convents, of which the Capuchin monastery is interesting for remains of Roman reservoirs. There is a considerable museum both of antiquities and natural history, as well as a recently erected observatory; and the benevolent institutions comprise an orphanage, and a large civil hospital, under the superintendence of a medical board and the sisters of mercy, with a separate wing set apart for the accommodation of lunatic patients. There are also in the town a mint, an extensive custom-house, and barracks. Cagliari is the see of an archbishop, and the seat of the Sardinian Cortes, and of the judicial court for the southern division of the island. The bay, formed by the projection of Cape Carbonara and Cape Pula, and stretching inland for a distance of 12 miles, with an extreme width of 24 miles, contributes greatly to the commercial importance of the city; and the harbour, situated at the south angle of the wall of the Marina quarter, is one of the safest in the Mediterranean, being well sheltered from every wind except the south. Frequent proposals have been made to extend the area by the construction of a breakwater, but this has not as yet been effected. Cagliari is the chief port of Sardinia, and possesses by far the greatest part of the export trade, which principally consists of corn, fruits, oil, wine, cork, lead, and a few native manufactures. Most important of the last class is salt, procured, at the rate of 683,000 quintals per annum, from the salt-pans to the west of the town. In 1873 the total value of exports from the province, most of which pass through the port, was £519,234; while the imports of the same year were of the value of £368,028. There is regular steam communication with Naples, Leghorn, and Genoa, as well as less frequently with other ports. The railway from Cagliari to Iglesias, a distance of 33½ miles, opens up the most important lead mines at present in operation, and a line of 58½ miles leads to Oristano. There is a submarine telegraph to Malta and another to Bône in Algeria. The climate of the town, in spite of the proximity of the salt swamp already mentioned, is excellent; and water, the want of which was formerly severely felt, is now supplied by an English company. Population in 1871, 33,039.

The modern city occupies the site of the ancient *Carales* or *Caralis*, which was founded by the Carthaginians, and passed into the hands of the Romans after the first Punic war. Of the buildings erected by the latter people there are several extensive remains,—those of an amphitheatre cut out in great part from the rock, a large aqueduct, a circular temple, &c.; while in the suburb of St Avandrace are

numerous Roman sepulchres, of which the most interesting is that of Atilia Pomptilla. In the civil war between Cæsar and Pompey, and during the empire, Cagliari was an important naval station; and, though it never obtained the status of a Roman colony, its inhabitants received the right of citizenship. Under Tiberius its population was augmented by the introduction of 4000 Jews, whose descendants were only expelled by the Spaniards in 1492. After the fall of the Western empire the city continued under the Vandals to be the capital of the island, and retained its importance during the Middle Ages. In 1353 the Genoese were disastrously beaten in the neighbouring sea by the Aragonese and the Venetians. In 1708 the town was bombarded by the English under Admiral Lake; in 1717 it was captured by the Spaniards; in 1779 it suffered from a great famine; and in 1793 it was bombarded by the French. From 1799 to 1815, while Savoy was in the hands of the French, Cagliari afforded a residence to the king of Sardinia.

CAGLIARI, PAOLO. See VERONESE.

CAGLIOSTRO, ALESSANDRO, COUNT (1743-1795), the arch-impostor of modern times, was born at Palermo in 1743. Joseph Balsamo—for such was the count's real name—gave early indications of those talents which afterwards gained for him so wide a notoriety. He received the rudiments of his education at the convent of Cartagirone; where, being employed to read to the monks during dinner, he scandalized the good fathers by repeating the names and detailing the adventures of the most notoriously profligate females of his native town. For these and similar misdeeds he was expelled from the convent and disowned by his relations. He now signalized himself by the ingenuity with which he contrived to perpetrate crimes without exposing himself to the risk of detection. He began by forging tickets for the theatres; then he forged a will; he next robbed his own uncle, and ultimately committed a murder. For the last offence he was imprisoned and brought to trial; but through a defect in the evidence, he escaped with his life. On his release he engaged a goldsmith, by name Marano, to assist him in searching for a hidden treasure,—Marano paying 60 oz. of gold in advance to defray expenses. On arriving at the cave where Joseph declared the treasure to be, six devils, prepared beforehand, rushed out upon the goldsmith, beat him soundly, and left him insensible. Dreading the vengeance of Marano, Balsamo quitted Sicily, and visited in succession Greece, Egypt, Arabia, Persia, Rhodes (where he took lessons in alchemy and the cognate sciences from the Greek Althotas), Malta, Naples, Rome, and Venice. At Rome he married a beautiful but unprincipled woman, with whom he travelled, under a variety of names, through the various countries of Europe. It is unnecessary to recount the various infamous means which he employed to support himself during his travels. At Strasburg he reaped an abundant harvest by professing the art of making old people young; in which pretension he was seconded by his wife Lorenza Feliciani, who, though only twenty years of age, declared that she was sixty, and that she had a son a veteran in the Dutch service. In Paris he was implicated in the affair of the diamond necklace; and though he escaped conviction by the matchless impudence of his defence, he was imprisoned for other reasons in the Bastille. On his liberation he visited England, where he succeeded well at first; but he was ultimately outwitted by some English lawyers, and was confined for a while in the Fleet. Leaving England, he travelled through Europe till he arrived at Rome, where he was arrested in 1789. He was tried and condemned to death for being a Freemason, but the sentence was afterwards commuted to perpetual imprisonment. He died in the fortress prison of San Leo in 1795. The best account of the life, adventures, and character of Joseph Balsamo is contained in Carlyle's *Miscellanies*. Dumas's novel, *Memoirs of a Physician*, is founded on his adventures. See also a series of papers in the *Dublin University Magazine*, vols. lxxviii. and lxxix.

CAGNOLA, LUIGI, MARQUIS (1762-1833), a celebrated architect, a native of Milan. He was sent at the age of fourteen to the Clementine College at Rome, and afterwards studied at the university of Pavia. He was intended for the legal profession, but his passion for architecture was too strong, and after holding some Government posts at Milan, he entered as a competitor for the construction of the Porta Orientale. His designs were commended, but were not selected on account of the expense their adoption would have involved. From that time Cagnola devoted himself entirely to architecture. After the death of his father he spent two years in Verona and Venice, studying the architectural structures of these cities. In 1806 he was called upon to erect a triumphal arch on the occasion of Eugène Beauharnais's marriage with the princess of Bavaria. The arch was of wood, but was of such beauty that it was resolved to carry it out in marble. The result was the magnificent Arco della Pace in Milan, one of the grandest erections of modern architecture, surpassed in dimensions only by the Arc de l'Étoile at Paris. Among other works executed by Cagnola are the Porta di Marengo at Milan, the Campanile at Urgnano, and the chapel of Santa Marcellina in Milan. He died on the 14th of August 1833.

CAGOTS, a people found in the Basque provinces, Béarn, and Gascony. During the Middle Ages they were popularly looked upon as crétins, lepers, heretics, and even as cannibals. Entirely excluded from all political and social rights, they were not even allowed to enter a church but by a special door, or to remain except in a part where they were carefully secluded from the rest of the worshippers. To partake of the mass was never permitted them. They were compelled to wear a distinctive dress, to which, in some places, was attached the foot of a goose or duck (whence they were sometimes called *Canards*). And so pestilential was their touch considered that it was a crime for them to walk the common road barefooted. The only trades allowed them were those of butcher and carpenter, and their ordinary occupation was wood-cutting. Their language is merely a corrupt form of that spoken around them; but a Teutonic origin seems to be indicated by their fair complexions and blue eyes. Their crania have a normal development; their cheek-bones are high; their noses prominent, with large nostrils; their lips straight; and they are marked by the absence of the auricular lobules. Upon the last peculiarity great stress is laid by anthropologists, and it is held to point to a Gothic origin. The common opinion of authorities is that this people are descendants of the Visigoths, and M. Michel derives the name from *caas* (dog) and *Goth*. But opposed to this etymology is the fact that the word *cagot* is first found in the *for* of Béarn not earlier than 1551, while the older MSS. call these peoples *Chrétiens*, or *Chrestiaas*, a term which, on this hypothesis, would have its origin from the fact that these Visigoths, left behind in Aquitaine, were Christians, while the Gascons were still Pagans. On the contrary, M. Marca, in his *Histoire de Béarn*, holds that the word signifies "hunters of the Goths," and that the Cagots are descendants of the Saracens. Again, some would make them descendants of the Albigenses; others of crétins (they are sometimes called Crétins); and others of lepers, declaring their name to be connected with the Celtic *caccod* and the Spanish *gafo*. In the laws of Navarre (1704) they are indeed styled *gaffos*, and treated as lepers; but in those of Béarn, they are clearly distinguished from them.

Small communities, believed to be of the same race, and existing in a similar social condition, being classed with them as "*les races maudites*," are to be found in Maine, Anjou, Poitou, and Aunis, under the name of *Colliberts* (a word said by Ducange to be derived from *cum* and *libertus*, and signifying "neither free nor slave"); in Brittany, under the names *Cahets* *Caqueux*, *Cacous*,

Caquins, or *Cacvas*; in Auvergne, under that of *Marrons*. Considerable numbers of the Colliberts still live in the *Marais mouillés de la Sèvre*; and the Cagots may be found round Jaca, in Guipuzcoa, in Navarre, at Cherbitua d'Anhauze in the valley of Azun, near Saint-Jean-Pied-de-Port and Saint-Jean-le-Vieux, and in the villages of Agotetchiac, Tailhapé, and Ainchicharburu, but in largest numbers in Labour, in the Basque arrondissement of Bayonne.

See Michel, *Histoire des races maudites*; L'Abbé Venuti, *Recherches sur les Cahets de Bordeaux*, 1754; *Bulletins de la Société Anthropologique*, 1861, 1867, 1868, 1871; *Annales medico-psychologiques*, Jan. 1867; M. Lagneau, *Questionnaire sur l'ethnologie de la France*.

CAHORS, a town in the south of France, formerly the capital of Cahourcin or Upper Quercy, and now of the department of Lot, on the high road between Paris and Toulouse, 358 miles S.W. from Paris, and 60 miles north of Toulouse, in 44° 27′ N. lat., 1° 24′ E. long. It stands on the right bank of the River Lot, on a rocky peninsula formed by a bend in the stream, and communicates with the opposite shore by three bridges,—one, the Pont Valendré, built in the 13th century, and surmounted by three massive towers. In the more ancient part of the town the streets are narrow and the houses antique; but in the modern and more elevated quarter there are many handsome buildings, with terraces which command an extensive view. The most remarkable building is the cathedral, built in the 11th or 12th century, and occupying the site, if not actually consisting of the remains, of an ancient Roman temple. Besides it, there is the theological seminary, the prefecture (formerly an episcopal palace), an academy, a theatre, a public library, and a monument erected to Fénelon in front of the cathedral. Cahors is the see of a bishop, and the seat of judicial and commercial tribunals of the first class. Its university, founded by Pope John XXII. in 1332, was incorporated with that of Toulouse in 1751. The principal articles of manufacture are stoneware, cotton-yarn, woollen stuffs, and paper; and it has a considerable traffic in oil, hemp, flax, hides, truffles, and a strong deeply-coloured wine, which is made in the neighbouring districts. Population of the town in 1872, 13,061, and of the commune 14,593.

Cahors is the ancient *Divona*, afterwards called *Civitas Cadurcorum*, from the Celtic tribe of which it was the capital, and still exhibits traces of its greatness during the Roman sway. The most conspicuous remains are those of an immense aqueduct, which conveyed the water to the city from a distance of about 19 miles by a precipitous route along the mountain sides, and crossed the valley of Larroque-des-arcs on a bridge 180 feet high. There are also remains of baths and a theatre, a marble altar in front of the prefecture (erected, according to the inscription, in honour of Lucterius Leo); and a celebrated fountain, supposed to be the fountain Divona, and now called Des Chartreux, from the Carthusian convent to which it has been attached.

After the decline of the Roman empire Cahors passed in succession into the hands of the Goths the Franks, the Saracens, and the Normans; and in the 12th century it was the subject of severe fighting between the English and French. In 1572 the Protestant party in the town were strong enough to prevent their fellow-citizens following the example of Paris; and yet a few years later, in 1580, we find the opposition to Henry of Navarre so violent that he only made himself master of the place after several days of conflict. The bishops of Cahors, who date from the 4th century, had formerly also the title of count, and used to lay their sword and gauntlets on the altar when about to officiate. During the Middle Ages the town is said to have been a great seat of the Caorsini (Cawertschen or Cauder-Wälsche), who preceded the Lombards as usurers and money-changers.

See Chaudruc de Crazannes, *Coup d'œil sur les monuments historiques du département du Lot*; Dufour, *La commune de Cahors au moyen âge*, 1846.

CAILLE, Nicolas Louis de la. See La Caille.

CAILLIÉ, or Caillé, René (1799–1838), a French traveller in Africa, was born in 1799 at Mauzé, and died in 1838. His school education extended no farther than reading and writing; and at the age of sixteen he commenced his career by a voyage to Senegal. But already *Robinson Crusoe* had kindled within him an enthusiastic admiration for the life of the discoverer; and in 1827, having collected 2000 francs by toiling on an indigo plantation, he set out on his most important mission. From Kakundy he travelled east by Cambaya, Kankan, Time, and Tangrera, and north-east by Donasso as far as Galia, through a hitherto unvisited district; and from Galia he passed through the country explored by Mungo Park to Timbuctoo, which he reached on April 20, 1828. He thus won the prize of 10,000 francs offered by the Geographical Society of Paris to the first traveller who should gain exact information of Timbuctoo, to be compared with that given by Mungo Park. He also received the order of the Legion of Honour, a pension, and other distinctions, and it was at the public expense that his *Journal d'un Voyage à Temboctou et Jenné dans l'Afrique Centrale, &c.*, was published in 1830.

CAIN, the eldest son of Adam and Eve according to the narrative of the Jehovist (Gen. iv.) Various derivations of the name have been suggested, the most probable being from קָנָה, "to obtain," the word used in Gen. iv. 1: "Eve bare Cain, and said, I have gotten a man from the Lord." According to the Biblical narrative (Gen. iv.) Cain was a tiller of the ground, while his younger brother, Abel, was a keeper of sheep. Enraged at the acceptance of Abel's offering by the Lord, and the rejection of his own, he slew his brother in the field. For this a curse was pronounced upon him, and he was condemned to be a "fugitive and a vagabond" on the earth, a mark being set upon him "lest any finding him should kill him." He took up his abode in the land of Nod, on the east of Eden, where he built a city, which he named after his son Enoch. The narrative presents a number of difficulties, which commentators have sought to solve with more ingenuity than success. On the reason for the preference of Abel's offering to Cain's some light is thrown by the references in the New Testament (Heb. xi. 4; 1 John iii. 12). The phrase "the Lord set a mark upon Cain" is perhaps more accurately rendered "the Lord gave a sign to Cain," and has been variously explained as referring to some pledge of safety given to Cain personally, or to some sign of warning and prohibition to mankind in general. There is an apparent contradiction between the condemnation of Cain to lead a nomadic life (ver. 12) and his subsequent settlement in a city, which it has been sought to reconcile by making the doom refer to the natural restlessness of the criminal and estrangement from the Adamic home. The endeavours that have been made to fix the precise locality of the land of Nod are based upon mere conjecture. The implied existence of a considerable population on the earth (ver. 14) furnishes another difficulty, of which no explanation that has been offered seems completely satisfactory. The parallelism between the list of Cain's descendants (Gen. iv. 18) and the list of the descendants of Seth (Gen. v.) has led several critics to identify the two, though it is denied by others that the mere similarity of the names gives any reasonable ground for doing so.

A Gnostic sect of the 2d century were known by the name of Cainites. They are first mentioned by Irenæus, who connects them with the Valentinians. They believed that Cain derived his existence from the superior power, and Abel from the inferior power, and that in this respect he was the first of a line which included Esau, Korah, the Sodomites, and Judas Iscariot.

CAIRN (in Welsh, *Carne*), a heap of stones piled up in a conical form. In modern times cairns are often erected as landmarks. In ancient times they were erected as sepulchral monuments or tribal and family cemeteries;

The *Duan Eireanach*, an ancient Irish poem, describes the erection of a family cairn; and the *Senchus Mor*, a collection of Irish laws ascribed to the 5th century, prescribes a fine of three three-year-old heifers "for not erecting the tomb of thy chief." Meetings of the tribes were held at them, and the inauguration of a new chief took place on the cairn of one of his predecessors. It is mentioned in the *Annals of the Four Masters* that, in 1225, the O'Connor was inaugurated on the cairn of Fraech, the son of Fiodhach, of the red hair. In mediæval times cairns are often referred to as boundary marks, though probably not originally raised for that purpose. In a charter by King Alexander II. (1221), granting the lands of Burgyn to the monks of Kinloss, the boundary is described as passing "from the great oak in Malevin as far as the *Rune Pictorum*," which is explained as "the Carne of the Pecht's fieldis." In Highland districts small cairns used to be erected, even in recent times, at places where the coffin of a distinguished person was "rested" on its way to the churchyard. Memorial cairns are still occasionally erected, as, for instance, the cairn raised in memory of the Prince Consort at Balmoral, and "Maule's Cairn," in Glenesk, erected by the earl of Dalhousie in 1866, in memory of himself and certain friends specified by name in the inscription placed upon it. See BARROWS.

CAIRNES, JOHN ELLIOTT, a distinguished political economist, was born at Drogheda in 1824, and died on the 8th July 1875. After leaving school he spent some years in the counting-house of his father, who was an extensive brewer. His tastes, however, lay altogether in the direction of study, and he was permitted to enter Trinity College, Dublin. He took the degree of B.A. in 1848, and six years later commenced as M.A. After passing through the curriculum of arts he engaged in the study of law and was called to the Irish bar. But he does not appear to have felt any very strong inclination for the legal profession, and during some years he occupied himself to a large extent with contributions to the daily press, treating of the social and economical questions that affected Ireland. The subject to which at this time he devoted most attention was political economy, which he studied with great thoroughness and care. While residing in Dublin he made the acquaintance of Archbishop Whately, who conceived a very high respect for his character and abilities. In 1856 a vacancy occurred in the chair of Political Economy at Dublin founded by Whately, and Cairnes received the appointment. In accordance with the regulations of the foundation, the lectures of his first year's course were published. The book appeared in 1857, with the title *Character and Logical Method of Political Economy*, and did not, perhaps, receive so much attention as it deserved. It follows up and expands J. S. Mill's treatment in the *Essays on some Unsettled Questions in Political Economy*, and forms a most admirable introduction to the study of economics as a science. In it the author's peculiar powers of thought and expression are displayed to the best advantage. Logical exactness, precision of language, and firm grasp of the true nature of economic facts, are the qualities characteristic of this as of all his other works. If the book had done nothing more, it would still have conferred inestimable benefit on political economists by its clear exposition of the true nature and meaning of the ambiguous term law. To the view of the province and method of political economy expounded in this early work the author always remained true, and several of his later essays, such as those on *Political Economy and Land*, *Political Economy and Laissez-Faire*, are but reiterations of the same doctrine.

His next contribution to economical science was a series of articles on the gold question, published partly in *Fraser's Magazine*, in which the probable consequences of the increased supply of gold attendant on the Australian and Californian gold discoveries are analyzed with great skill and ability. The general conclusions arrived at in these papers with regard to the effects of the depreciation of gold—that finished manufactures would be on the average least altered in price; that raw produce, particularly the portion derived from the animal kingdom, would be most seriously affected; and that, on the whole, the section of the population most nearly concerned in the movement would be the class of labourers or artisans—are highly interesting, and have been confirmed to a remarkable extent by recent statistical researches. The further inferences drawn as to the international results likely to follow on the introduction into the several currencies of so large a mass of gold have not been borne out to the same extent. The facts were too complex to admit of accurate prediction. The articles attracted much attention at the time, and were highly commended by the most competent judges. A critical article on M. Chevalier's work *On the Probable Fall in the Value of Gold*, which appeared in the *Edinburgh Review* for July 1860, may be regarded as the sequel to these papers.

In 1861 Cairnes was appointed to the professorship of political economy and jurisprudence in Queen's College, Galway, and in the following year he published his admirable work *The Slave Power*, one of the finest specimens of applied economical philosophy. The inherent disadvantages of the employment of slave labour are exposed with great fulness and ability, and the conclusions arrived at have taken their place among the recognized doctrines of political economy. To a very large extent the opinions expressed by Cairnes as to the probable issue of the war in America were verified by the actual course of events.

During the remainder of his residence at Galway Professor Cairnes published nothing beyond some fragments and pamphlets, mainly upon Irish questions in which he was deeply interested. The most valuable of these papers are the series devoted to the consideration of university education in Ireland. His health, at no time very good, was still further weakened in 1865 by a fall from his horse, which inflicted severe injury on one of his legs. He was ever afterwards incapacitated from active exertion, and was constantly liable to have his work interfered with by attacks of illness. In 1866 he was appointed professor of political economy in University College, London. He was compelled to spend the session 1868–69 in Italy, but on his return continued to lecture till 1872. During his last session he conducted a mixed class, ladies being admitted to his lectures. His health soon rendered it impossible for him to discharge his public duties; he resigned his post in 1872, and retired with the honorary title of Emeritus Professor of Political Economy. In 1873 his own university conferred on him the degree of LL.D.

The last years of his life were spent in the collection and publication of some scattered papers contributed to various reviews and magazines, and in the preparation of his most extensive and important work. The *Political Essays*, published in 1873, comprise all the papers relating to Ireland and its university system, together with some other articles of a somewhat similar nature. The *Essays in Political Economy, Theoretical and Applied*, which appeared in the same year, contain the essays towards a solution of the gold question, brought up to date and tested by comparison with statistics of prices. Among the other articles in the volume the more important are the criticisms on Bastiat and Comte, and the Essays on *Political Economy and Land*, and on *Political Economy and Laissez-Faire*, which have been referred to above. In 1874 appeared his largest work, *Some Leading Principles of Political Economy, newly Expounded*, which is beyond doubt a

worthy successor to the great treatises of Smith, Malthus, Ricardo, and Mill. It does not expound a completed system of political economy; many important doctrines are left untouched; and in general the treatment of problems is not such as would be suited for a systematic manual. The work is essentially a commentary on some of the principal doctrines of the English school of economists, such as value, cost of production, wages, labour and capital, and international values, and is replete with keen criticism and lucid illustration. While in fundamental harmony with Mill, especially as regards the general conception of the science, Cairnes differs from him to a greater or less extent on nearly all the cardinal doctrines, subjects his opinions to a searching examination, and generally succeeds in giving to the truth that is common to both a firmer basis and a more precise statement. The last labour to which he devoted himself was a republication of his first work on the *Logical Method of Political Economy*, which had long been out of print. The second edition appeared in April, a few months before the author's untimely death.

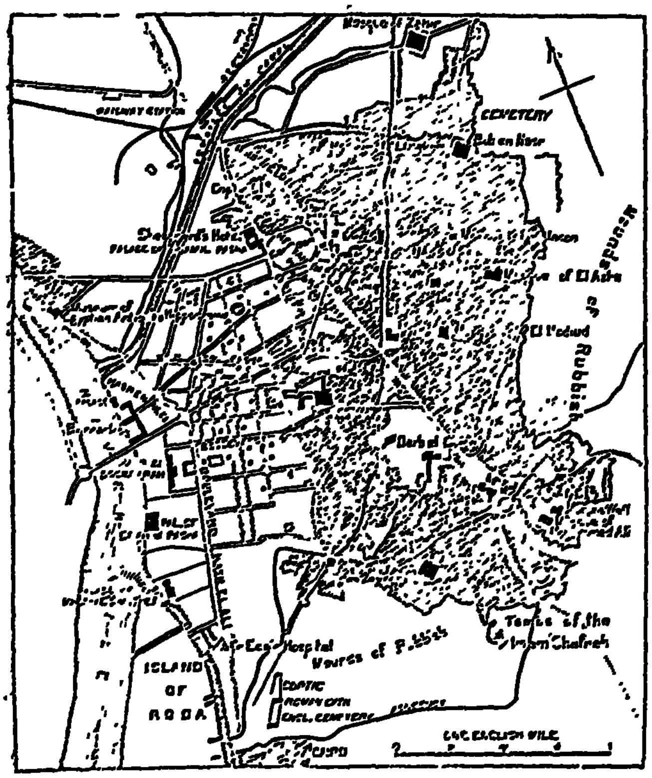
Taken as a whole the works of Cairnes form the most important contribution to economical science made by the English school since the publication of J. S. Mill's *Principles*. As has been already pointed out, they possess especial value by reason of the writer's firm grasp of the nature, method, and limits of the science he is engaged in expounding. It is not possible to indicate more than generally the special advances in economic doctrine effected by him, but the following points may be noted as establishing for him a claim to a place alongside of Ricardo and Mill:—(1.) His exposition of the province and method of political economy. He never suffers it to be forgotten that political economy is a *science*, and consequently that its results are entirely neutral with respect to social facts or systems. It has simply to trace the necessary connections among the phenomena of wealth, and dictates no rules for practice. Further, he is distinctly opposed both to those who would treat political economy as an integral part of social philosophy, and to those who have attempted to express economic facts in quantitative formulæ, and to make economy a branch of applied mathematics. According to him political economy is a mixed science, its field being partly mental, partly physical. It may be called a positive science, because its premises are facts, but it is hypothetical in so far as the laws it lays down are only approximately true, *i.e.*, are only valid in the absence of counteracting agencies. From this view of the nature of the science, it follows at once that the method to be pursued must be that called by Mill the Physical or Concrete Deductive, which starts from certain known causes, investigates their consequences, and verifies or tests the result by comparison with facts of experience. It may, perhaps, be thought that Cairnes gives too little attention to the effects of the organism of society on economic facts, and that he is disposed to overlook what have recently been called by Mr Bagehot the postulates of political economy. (2.) His analysis of cost of production in its relation to value. According to Mill, the universal elements in cost of production are the wages of labour and the profits of capital. To this theory Cairnes objects that wages, being *remuneration*, can in no sense be considered as *cost*, and could only have come to be regarded as cost in consequence of the whole problem being treated from the point of view of the capitalist, to whom, no doubt, the wages paid represent cost. The real elements of cost of production he looks upon as labour, abstinence, and risk, the second of these falling mainly, though not necessarily, upon the capitalist. In this analysis he to a considerable extent follows and improves upon Senior, who had previously defined cost of production as the sum of the labour and abstinence necessary to production. (3.) His exposition of the natural or social limit to free competition, and of its bearing on the theory of value. He points out that in any organized society there can hardly be the ready transference of capital from one employment to another, which is the indispensable condition of free competition; while class distinctions render it impossible for labour to transfer itself readily to new occupations. Society may thus be regarded as consisting of a series of non-competing industrial groups, with free competition among the members of any one group or class. Now the only condition under which cost of production will regulate value is perfect competition. It follows that the normal value of commodities—the value which gives to the producers the average and usual remuneration—will depend upon cost of production only when the exchange is confined to the members of one class, among whom there is free competition. In exchange between classes, or non-competing industrial groups, the normal value is simply a case of international value, and depends upon reciprocal demand, that is to say, is such as will satisfy the equation of demand. This theory is a substantial contribution to economical science, and throws great light upon the general problem of value. At the same time, it may be thought that Cairnes has overlooked a point brought forward prominently by Senior, who also had called attention to the bearing of competition on the relation between cost of production and value. The cost to the producer fixes the limit below which the price cannot fall without the supply being affected; but it is the desire of the consumer—*i.e.*, what he is willing to give up rather than be compelled to produce the commodity for himself—that fixes the maximum value of the article. To treat the whole problem of natural or normal value from the point of view of the producer is to give but a one-sided theory of the facts. (4.) His defence of the wages fund doctrine. This doctrine, expounded by Mill in his *Principles*, has not been universally accepted even by British economists, and has recently been assailed with great vigour by Thornton and F. D. Longe. In consequence of these attacks it has been relinquished by Mill, but Cairnes still undertakes to defend it. He certainly succeeds in removing from the theory much that has tended to obscure its real meaning, and in placing it in its very best aspect. He has also shown the sense in which, when treating the problem of wages, we must refer to some fund devoted to the payment of wages, and has pointed out the conditions under which the wages fund may increase or decrease. But he has not, it seems to us, been successful in showing that the theory is fruitful, or gives any satisfactory explanation of the many complicated questions connected with the varying rates of wages.

These points, of course, do not comprehend all or nearly all that Cairnes has handled in his peculiarly fresh and attractive manner. *The Leading Principles*, for instance, contain admirable discussions on trades unions and protection, together with a clear analysis of the difficult theory of international trade and value, in which there is much that is both novel and valuable, while numerous minor topics are treated throughout the volume. The *Logical Method* contains the best exposition and defence known to us of Ricardo's theory of rent; and the *Essays* contain what is probably the most complete and successful criticism of Bastiat's economic doctrines. (R. AD.)

CAIRNGORM, or CAIRNGORUM, a name popularly applied to a wine-yellow or brown variety of rock crystal found, among other localities, on the Grampian Mountains in the south-east of Banffshire, Scotland, the central peak being called Cairngorm. The colour of the crystals, which is due to a minute proportion of iron oxide, varies, passing through those above noted as belonging properly to cairngorms, into a dull grey, smoky quartz, and to a black

variety, called morion. The same stone is found in commerce passing under the names of false topaz, Brazilian topaz, occidental topaz, and cinnamon stone (*pierre de cannelle* of the French). It is found in many parts of the world, Brazil producing the finest deep brown varieties; but fine stones also come from India, Bohemia, Mexico, and Pennsylvania. It is also found at the Carnbrae Mines, in Cornwall. In the cairngorm district masses weighing as much as 25 lb have been obtained, and an Edinburgh lapidary cut nearly £400 worth of ornamental stones out of a single crystal. The cairngorm is chiefly used for Scotch jewellery, the mounting of gold and silver plaid-brooches, setting in the lids of snuff-mulls, the handles of dirks, &c., and the ornamentation of other articles connected with the Highland costume. The stones are most effectively set by covering the undersets entirely with oblong facets arranged in regular rows, surrounding the table with triangular facets and keeping the stone as thick as possible. By this means great brilliancy combined with depth of colour, is secured

CAIRO (in Arabic, Misr-al-Kahira, or, as the lower classes of the population call it, simply Masr), the modern capital of Egypt, occupies the natural centre of the country,



Ground-Plan of Cairo.

1. Karameydan (Place Mehemet Ali)
2. Ezbekiyeh Gardens
3. Post-Office.
4. French Theatre
5. Opera House.
6. English and German Churches.

being situated on the east bank of the Nile, 12 miles above the apex of its delta, 150 miles by rail from Alexandria, and 80 west from Suez, in 30° 2′ 4″ N. lat. and 31° 15′ 26″ E. long. It is built partly on the plain and partly on the lower slopes of the rocky range of Mokattem, on a spur of which stands the citadel, 250 feet above the level of the town. The prospect from the ramparts of this fortress is one of great magnificence and beauty. Below lies the city with its strongly-built walls and lofty towers, its gardens and squares, its palaces, and its mosques, in all the beauty of their delicately-carved domes and minarets covered with fantastic tracery, the port of Bulak, the gardens and palace of Shubra, the broad river studded with islands, the valley of the Nile dotted with groups of trees, with the pyramids on the north horizon, the fields, gardens, and villas on the west, and on the east the barren cliffs, backed by an ocean of sand.

As far as the portion within the walls is concerned, Cairo occupies a site of about seven miles in circumference; but during the reign of the khedive (properly *hidiv*), who was born in the city in 1830, it has extended, especially towards the river, so as to have a circuit of at least 8 or 9 miles. Its improvement has kept pace with its extension, and it can no longer be altogether described as little better than a labyrinth of tortuous lanes, narrow, unpaved, and continually swept with clouds of dust blown from huge mounds of rubbish outside the walls. New streets have been cut through the more crowded districts; and the Ezbekeeyah, the principal square of the city, which was formerly allowed to lie waste, has been transformed into public gardens with a lake in the centre, while houses and shops of considerable pretensions have sprung up in the neighbourhood. Most important of the new streets is the Boulevard Mehemet Ali, which traverses the city in an almost northerly direction from the Citadel to the Ezbekeeyah. Between the western side of the older city and the river most of the ground has been laid out in building lots, and in various parts, as particularly in the direction of Bulak, it is already covered with regular rows of houses, and forms the district of Ismaileeyah. Bulak, in fact, is not so much a distinct town as a mere suburb of the larger city. Gas has been laid down in all the principal streets, and water is supplied by a company to the houses of all those who comply with the necessary regulations. In spite of all these innovations, however, the city largely retains its Oriental character, and in a hundred of its narrow streets it is easy to forget that any change at all has taken place.

The most of the houses of the poorer classes consist of miserable mud hovels, with filthy courts, dilapidated windows, and tattered awnings. In marked contrast to these are the houses of the wealthier citizens, built generally in a style of elaborate arabesque, the windows shaded with projecting cornices of graceful woodwork, and ornamented with stained glass. A winding passage leads through the ornamented doorway into the court, in the centre of which is a fountain shaded with palm-trees. The principal apartment is generally paved with marble; in the centre a decorated lantern is suspended over a fountain, whilst round the sides are richly inlaid cabinets and windows of stained glass; and in a recess is the *divan*, a low, narrow cushioned seat running round the walls. The basement story is generally built of the soft calcareous stone of the neighbouring hills, and the upper story, which contains the harem, of painted brick.

The town is walled off into quarters, deriving their names from the character or condition of their occupants, and is intersected in its whole breadth by a canal which conveys the waters of the Nile from Old Cairo to the different parts of the city. The citadel or El-Kalah was built by Saladin about 1166, but it has since undergone frequent alteration, and now contains a palace erected by Mehemet Ali, and a mosque of Oriental alabaster founded by the same pasha on the site of "Joseph's Hall." In the centre is a well called Joseph's Well, sunk in the solid rock to the level of the Nile. Next to the citadel in importance are the mosques, 400 in number, including, however, many that are falling to ruins. The most magnificent is the Mosque of Sultan Hasan, standing in the immediate vicinity of the citadel. It dates from 1357, and is celebrated for the grandeur of its porch and cornice, and the delicate honeycomb tracery which adorns them. Besides it there is the Mosque of Tulun (founded 879 A.D.), exhibiting very ancient specimens of the pointed arch; the Mosque of Sultan el

Hakem, the fanatical patron of the Druzes, founded in 1003, the Mosque Al Azhar ("The Splendid"), which is principally famous as the seat of a Mahometan university, in which gratuitous instruction is given in the Koran; and the Mosque of Sultan Kalaoon, attached by its founder to the great Mooristan or madhouse, which he established in 1287. The Mooristan is no longer used for its original purpose, having been superseded by an asylum at Bulak. There is also a large general hospital situated between Bulak and Old Cairo, under the charge of native doctors.

On the east of the city are the splendid structures erroneously known to Europeans as the tombs of the caliphs; they really belong to the Circassian or Borgite Mamelukes, a race extinguished by Mehemet Ali. Their lofty gilt domes and fanciful network of arabesque tracery are falling to ruins, and the mosques attached to them are the haunts of a few solitary sheikhs, and of hordes of Arab beggars.

Among the buildings which owe their existence to modern European influence, the Italian opera, the French theatre, and the hippodrome may be mentioned. In Bulak is situated the Government printing-press, established by Mehemet Ali, from which numerous Oriental works and translations of French originals are issued from time to time; and in a building by the river side is accommodated the unrivalled collection of Egyptian antiquities made by M. Mariette for the khedive. The manuscripts which were formerly scattered among the various mosques and other institutions were recently collected to form a public library in the palace of the Darb Algamâmîz or Sycamore Street. The catalogue already occupies 333 pages, and the collection is especially rich in copies of the Koran and works of grammatical exegesis. In 1875 a geographical society was founded by the khedive for purposes of African discovery. A few periodicals are published in the city, but in this respect Cairo is much behind Alexandria. The scheme of public instruction is mainly that which was organized by Mehemet Ali, and embraces primary, preparatory, and special schools. In 1872 there were 1025 students and 141 teachers in the Government colleges, and the national schools were attended by 4721 pupils, while in the Mosque Al Azhar 6774 were enrolled. The higher scholastic institutions comprise a commercial and a juridical school at the Darb Algamâmîz, a school of arts and industry at Bulak, and military schools at the Abbasseeyah. There are several Christian churches and missionary stations in the city, and most of these maintain some educational machinery, so that there are Armenian, Greek, Coptic, Roman Catholic, and Protestant schools. Of special interest to Englishmen is Miss Whately's institution in the Abbasseeyah road.

The commerce of Cairo is of considerable extent and variety, but consists mainly in the transit of goods. Gum, ivory, hides, and ostrich feathers from the interior, cotton and sugar from Upper Egypt, indigo and shawls from India and Persia, sheep and tobacco from Asiatic Turkey, and European manufactures, such as machinery, hardware, cutlery, glass, and woollen goods, are the more important articles. The traffic in slaves, which was at one time so striking a feature of the place, is still carried on to a certain extent. In Bulak are several factories founded by Mehemet Ali for spinning, weaving, and printing cotton, and a paper-mill established by the khedive in 1870 at a cost of about £80,000. Various kinds of paper are manufactured, and especially a fine quality for use in the Government offices. In the island of Rhoda, or Roudah, there is a sugar-refinery of considerable extent, founded in 1859, and principally managed by Englishmen. Silk goods, saltpetre, gunpowder, leather, &c., are also manufactured. An iron bridge has been erected over the Nile between the Kasr el Dubbara on the right bank and Gezirah on the left; and new carriage roads, bordered by acacias and sycamore trees, have been constructed to Heliopolis and the pyramids of Gizeh respectively. The terminus of the railway lines of the delta and isthmus is situated to the north of the city, but the Upper Egypt line stops short on the left bank of the river at Embabah opposite Bulak, and the trains have to be taken across by a ferry.

From the central situation of Cairo, and its proximity to the hot sandy deserts, the temperature is much higher there than near the coast; but the diseases which infest it, such as the plague, ophthalmia, and malignant fevers, seem to originate in its "stifled filth," and other local causes, which advancing civilization will greatly remove, rather than in the unhealthiness of its situation. Its death-rate is greater than that of any European capital, but this is partly to be accounted for by the fact that numbers of natives come to the city in order that their last hours may be spent within its walls. The greatest mortality is during winter, and a larger proportion of deaths is caused by consumption than by any other disease. The average temperature throughout the year is 71°·16 Fahr.; but the mean of the separate months varies from 54° in January to 86° in August. The temperature by night is sometimes 40° below the highest point reached during the day, more especially in March and April, when the south and south-west winds prevail, and the thermometer frequently rises to upwards of 100° in the shade. In 1871 the number of rainy days was only 9, and the total duration of the fall was 9 hours 8 minutes.

The population of Cairo is of a very mingled description, and presents a very picturesque and interesting appearance. About the beginning of this century it was estimated to amount to about 200,000, which was supposed to comprise 121,000 Mahometans, 60,000 Copts, 4000 Jews, and a number of Franks, Greeks, and Armenians. It now numbers about 350,000, which may be distributed in the following proportions:—285,000 natives, 25,000 Nubians and natives of the Soudan, 10,000 Turks, 30,000 Jews and Levantines, and upwards of 19,000 Europeans. The German and English colonies are both pretty numerous, and possess each its own church.

About 2¼ miles S.W. of the citadel, and 1¾ from the S.W. angle of the city, lies the town of Misr-al-'Atikah, or Old Cairo, situated on the Nile near the mouth of the canal which now flows through Cairo, and opposite to the famous Nilometer at the south end of the island of Raudah. It occupies the site of the ancient Roman city or fortress of Babylon, of whose origin various stories of apparently little value are told by Diodorus and others. The place appears in Ptolemy's *Tables*, and Strabo mentions that it was the headquarters of one of the three Roman legions that garrisoned Egypt. Roman masonry survives as part of a convent enclosure, which is known by the names Kasr-es-Shama ("Palace of the Candle") and Dair-en-Nasarah ("Convent of Christians").

The name Babylon of Egypt, or Babylon simply, is frequently employed in mediæval writings as synonymous with Cairo, or as denoting the successive Mahometan dynasties of Egypt. This use may have been influenced by the association of the other Babylon, as represented by Baghdad, with the power of Islam: but at the same time it was a real survival from the ancient name; for Babylon on the Nile is mentioned by Gregory of Tours (circa [illegible] A.D.), in connection with the *Granaries of Joseph*—i.e. the Pyramids. Here Amru the famous conqueror of Egypt for the Caliph Omar (638) founded a city to which was given the name of Fostât, it is said from Amru's skin tent (so called in Arabic). It continued to be the capital of Egypt for upwards of 330 years. In 973 it was superseded by a new city founded shortly before by Jauher (Gowher), captain of the first Fatimite caliph, Al [illegible], whose army had conquered Egypt in 969. It is said that the new city was originally the camp of Jauhar whilst besieging Fostât, which gradually grew into a town, and got the name of Al [illegible] ("Victrix"), whence our Cairo. In 1176 the city was attacked by [illegible] the Franks; and shortly afterwards it was fortified by [illegible]. It was the capital of the Turkish province of Egypt from 1517 to 1798, when it was captured by the French, who were driven out in 1801 by the Turkish and English forces. Mehemet Ali secured his position by the massacre of the Mamelukes in the citadel in 1811, and laid the basis of the independence of Egypt.

CAIRO, a city of the United States, capital of Alexander county, Illinois, situated between the Ohio and Mississippi, at the extreme south of the State, 147 miles from St Louis by rail. On account of its low situation it has often suffered from inundations, especially in the summer of 1858, when it was nearly destroyed, but it is now better protected by embankments. Steamers ply between the city and the Ohio and Mississippi ports, and it is an important depot for the produce of the neighbouring States. Large warehouses have recently been built, and both city and trade are steadily increasing. Cairo possesses a fine custom-house and county buildings. Population in 1860, 2188, and in 1870, 6267.

CAISSON, in engineering work, is a chamber of iron or wood which is used in the construction of subaqueous foundations,—such as those required for the piers of bridges, &c. Its object is the same as that of a coffer-dam, viz., to allow the work to be carried on below the water-level,—but it is used in places where either the water or the permeable soil is too deep to allow a dam to be erected. In cases where the bridge piers are hollow cylinders of iron, they not unfrequently form their own caissons,—their own weight, or that of ballast placed upon them, forcing their lower edges into the ground. The material left within them is dredged up or excavated as they descend. Where, however, the soil is not so soft, or is mixed with stones, this self-lowering becomes impossible. The lower part of the caisson is then commonly formed into an air chamber, open at the bottom, and resting upon the bed of the river Air is pumped into this at a pressure corresponding to its depth below the surface of the water, and the excavation is carried on by men working in the compressed air as in a large diving-bell. In some cases the masonry of the pier is built within the caisson on the top of the chamber as it descends, the chamber itself being eventually filled up with masonry or concrete, and left to form the permanent base of the structure; in others the caisson is lowered (as the excavation goes on) by weights; and when the required depth has been reached, the masonry is commenced within the air-chamber, and the whole caisson raised again as the building proceeds. Probably the largest caissons ever used are those of the East River Suspension Bridge (a structure still unfinished) at New York, of which one was 172 feet long by 102 feet wide. See BRIDGES. For military caissons see FORTIFICATION.

CAITHNESS, the most northern county of the Scottish mainland, bounded W. and S. by Sutherlandshire, and E. and N. by the Northern Ocean, is situated between 58° 8′ and 58° 40′ N. lat., 3° 0′ and 3° 55′ W. long., and has an extreme length of 53 miles, an extreme breadth of 33, a coast line of 105 miles, and an area of 455,708 acres or 712 square miles. The form of Caithness resembles an irregular triangle, having as its greatest side the line of coast on the S.E., stretching from the Ord of Caithness to Duncansby Head. The surface of the county generally is flat and tame, consisting for the most part of barren moors, and being almost entirely destitute of trees. It presents a gradual slope from the north and east upwards to the ridge of hills on the west and south, which separates it from Sutherlandshire, and on the southern boundary, where it is bifurcated, attains considerable elevation. The one branch, called the Maiden Paps, contains the peak of Morven, 2334 above the level of the sea; the other, continuing in the line of the main ridge, juts into the sea, and terminates in the huge granitic precipice of the Ord. In the centre of the county, hemmed in by the hills on the western boundary, the ridge of the Maiden Paps, and the sea, is a large undulating plain comprising nearly four-fifths of the whole extent. On its southern side it is broken up by several detached hills, and in the interior contains a considerable number of small lakes. The most depressed part of the county lies in the peninsula formed in the north-east corner by the indentation of Dunnet Bay and Sinclair Bay. The more elevated portion presents a light sandy soil, which admits of considerable cultivation, but the low grounds are covered with extensive morasses, producing only heath and rough grass.

The geological formation consists chiefly of sandstone, sandstone flag, and occasionally limestone; but granite and gneiss are also found in the west. On the east Caithness presents a precipitous coast, with scarcely a creek in which a vessel, even of small size, can find shelter. On the northern coast, where the Pentland Firth separates it from the Orkney islands, stand at the distance of 13 miles from each other the two bold headlands of Duncansby Head on the north-east and Dunnet Head on the north-west. The latter, the most northern point of Scotland, is situated in 58° 40′ N. lat. and 3° 21′ W. long., and is crowned by a lighthouse, with a fixed light, built on the rock 346 feet above the level of the sea; while the former is marked by the white steeple of Cannisby on the west. The navigation of the Pentland Firth is attended with considerable danger, from the strength and eddies of the current. Off the island of Stroma, which is separated from the mainland by a strait three miles broad, is a small vortex called the Swalchie; while nearer the shore are the "Merry Men of Mey," a group of breakers caused by eddies between projecting headlands. On the east coast, in addition to the harbour of Wick, erected in 1831, at a cost of above £40,000, and since improved at further expense, there is a small harbour at Sarclett and another at Staxigoe, a small pier at Clyth and another at Lybster. On the northern coast Scrabster roads in Thurso Bay afford tolerably good anchorage, while at Thurso and Sandside Bay are commodious harbours for larger vessels.

The climate of Caithness is variable, but not unhealthy; and though the winter storms fall with great severity on the unsheltered coast, yet from its proximity to a large expanse of sea the cold is not intense and snow seldom lies many days continuously. In winter and spring the northern shore is subject to frequent and disastrous gales from the N. and N.W. The waters of Forss, Thurso, and Wick, are the principal streams which traverse the county, but none of them are of any particular importance. The largest lochs are those of Watten and Cathel; there are numerous small ones well stocked with trout.

A great change has been effected in the agricultural position of Caithness, chiefly by the late James Traill, Esq. of Ratter. The farms along the coast are still mostly in the hands of small farmers, who cultivate the soil only during the intervals of the fishing-season; but inland, in the more elevated districts, and along the banks of the principal streams, the land is let out into large farms, with leases long enough to encourage the holder to improve the soil and practise a rotation of crops. The average extent of land held by each occupier, in 1874, was 39 acres, much larger than the average in Sutherlandshire, which only amounted to 10 acres in the same year. In the pasturage ground, black cattle and sheep, chiefly of the Leicester and Cheviot breeds, are reared for the southern markets; and, independently of the weekly corn-markets at Thurso and Wick, the rapidity of communication with the south is opening up a valuable market for the produce of the dairy and farmyard.

The principal crops raised are oats, beans, potatoes, and turnips; wheat can be grown only where draining has been carried to considerable perfection. In 1874 there were only 87 acres in wheat, 1895 in barley, 70 in rye, and 27 in peas; while oats occupied 33,071 acres, turnips 14,045, and potatoes 2190. In the same year there were 21,567

acres in permanent pasture, and 6222 in temporary grass, while only 440 were covered with wood. The number of cattle of all kinds in the county was 22,616, sheep 108,829, horses 4969, and pigs 1789. But the great source of profit to the inhabitants is to be found in the fisheries of cod, ling, lobsters, and herring, which abound all around the coast. The most important is the herring-fishery, though it has considerably lessened in value during the last twenty or thirty years. Beginning about the end of July the season lasts for about six weeks, the centre of operations being at Wick and the surrounding districts. The number of fishermen employed in 1874 was 4304; and the value of boats, nets, lines, &c., for the same year, was estimated at £112,270. Besides those more immediately engaged in manning the boats, the fisheries give employment to a large number of coopers, curers, packers, and others. The salmon-fisheries on the coast and at the mouths of rivers were formerly very productive, and are still let at high prices. At intervals along the coast are valuable quarries of freestone and slate, and of excellent flag for pavements; but the county is far from rich in other minerals. Slight traces of lead and iron have been found in the mountainous districts; and indications of coal, or rather of bituminous shale, have been noticed at Cannisby. The only article of manufacture is woollen cloth. The Highland Railway, opened in 1873, enters the county from Sutherlandshire, and curves through the centre to Wick, passing Altnabreac, Scotscalder, Halkirk, Georgemas, Bower, Watten, and Bilbster; while a branch line runs from the Georgemas junction to Thurso.

The early history of Caithness may, to some extent, be traced in the various character of the remains and the diversity of its local nomenclature. Picts' houses, Norwegian names, and Danish mounds attest that the Celts were successively displaced by these different tribes; and the number and strength of its fortified keeps leave us to infer that its annals present the usual record of feuds, assaults, and reprisals. Circles of erect stones, as at Steinster Loch and Bower, and the ruins of Romanist chapels and places of pilgrimage in almost every district, illustrate the changes which have come over its ecclesiastical condition. The most important remains are those of Bucholie Castle, Girnigo Castle, and the tower of Keiss; and on the S.E. coast the castles of Clyth, Swiney, Forss, Latheron, Knockinnan, Berridale, Achastle, and Dunbeath,—of which the last is romantically situated on one of the detached pillars of sandstone rock that are frequent along the Caithness coast. About six miles from Thurso stand the ruins of Braal Castle, the residence of the ancient bishops of Caithness, and on the shores of the Pentland is situated the mythical site of John o' Groats' House. The total number of landowners in 1872–3 was 1030,—among the most important being the duke of Portland, with 81,605 acres; Sir John Sinclair of Tollemache, with 78,053; Mrs Thomson Sinclair of Fenswick, with 57,757; Sir Robert Anstruther of Balcaskie in Fife, with 36,597; and the earl of Caithness, with 14,460.

Caithness is divided into ten civil and twelve *quoad sacra* parishes, and contains twelve churches and two chapels of ease belonging to the Establishment (in four of which there is service in Gaelic); seventeen belonging to the Free Church (in seven of which there is service in Gaelic); one United Presbyterian, and one Roman Catholic at Wick.

The county returns one member to the imperial parliament. The parliamentary constituency in 1875–76 was 1172. The principal towns are Wick and Thurso; the most important villages are Broadhaven, Castletown, Louisburgh, Sarclett, and Staxigoe. The population in 1831 was 34,529; in 1841, 36,343; in 1851, 38,709; and in 1871, 39,992. In the last year the males numbered 18,937, and the females 21,055; and there were in the county at the same date 7474 inhabited houses, 203 vacant, and 431 building.

CAIUS, KAYE, or KEYE, Dr JOHN (1510–1573), the founder of Caius College in Cambridge, was born at Norwich in 1510. He was admitted while very young a student at Gonville Hall, Cambridge. From his exercises performed there it seems probable that he intended to prosecute the study of divinity. He visited Italy, where he studied under the celebrated Montanus at Padua; and in 1541 he took his degree in physic at Bologna. In 1543 he visited several parts of Italy, Germany, and France; and returning to England, he began to practise first at Cambridge, then at Shrewsbury, and afterwards at Norwich. He removed to London in 1547, and was admitted fellow of the College of Physicians, of which he was for many years president. In 1557, being then physician to Queen Mary, he obtained a licence to advance Gonville Hall into a college, and he endowed it with several considerable estates, adding an entire new square at the expense of £1834. Of this college he accepted the mastership, which he held till within a short period of his death. He was physician to Edward VI., Queen Mary, and Queen Elizabeth. Towards the end of his life he retired to his own college at Cambridge, where having resigned the mastership to Dr Leggie of Norwich, he spent the remainder of his life as a fellow commoner. He died in July 1573, and was buried in the college chapel. Dr Caius was a learned, active, and benevolent man. In 1557 he erected a monument in St Paul's to the memory of Linacre. In 1563 he obtained a grant for the College of Physicians to take the bodies of two malefactors annually for dissection; and he was the inventor of the *insignia* which distinguish the president from the rest of the fellows.

His works are—1. *Annals of the College from* 1555 *to* 1572. 2. Translation of several of Galen's works, printed at different times abroad. 3. *Hippocrates de Medicamentis*, first discovered and published by Dr Caius; also *De Ratione Victus*, Lov. 1556, 8vo. 4. *De Mendeti Methodo*, Basel, 1554; Lond. 1556, 8vo. 5. *Account of the Sweating Sickness in England*, Lond. 1556, 1721. It is entitled *De Ephemera Britannica*. 6. *History of the University of Cambridge*, Lond. 1568, 8vo; 1574, 4to, in Latin. 7. *De Thermis Britannicis*; but it is doubtful whether this work was ever printed. 8. *Of some Rare Plants and Animals*, Lond. 1570. 9. *De Canibus Britannicis*, 1570, 1729. 10. *De Pronunciatione Græcæ et Latinæ Linguæ*, Lond. 1574. 11. *De Libris propriis*, Lond. 1570. He also wrote numerous other works which were never printed.

CAJAZZO, or CAIAZZO, a town of Italy, in the province of Terra di Lavoro, and district of Piedimonte, situated on a height on the north bank of the Volturno, about 11 miles from Capua. It possesses a fine cathedral, and is defended by a castle of Lombard origin; but is principally interesting for the ruins of the Roman *Calatia*, which are still found in the town and neighbourhood. These consist chiefly of remains of the outer walls, and a cistern, which still affords a good supply of water. Various inscriptions are also extant, and the inhabitants point out a tomb which they maintain to be that of A. Atilius Calatinus. Calatia was originally a Samnite town, and is frequently mentioned in the earlier wars of the Romans. At a later date it became a municipal city of some importance, but makes no appearance in history. The population of the present town is 5892.

CAJEPUT OIL, a volatile oil obtained by distillation from the leaves of *Melaleuca leucadodendron*, and probably other species. The trees yielding the oil are found throughout the Indian Archipelago, the Malay peninsula, and over the hotter parts of the Australian continent; but the greater portion of the oil is procured from Celebes Island. The name Cajeput is derived from the native *Kayu-puti* or white wood. The oil is prepared from leaves

collected in a hot dry day, which are macerated in water, and distilled after fermenting for a night. As imported into Europe it has a greenish colour owing to the presence of a minute proportion of copper, which can be separated, leaving the oil perfectly colourless. This oil is extremely pungent to the taste, and has the odour of a mixture of turpentine and camphor. When dropped in water, it diffuses itself over the surface, and then entirely evaporates. Chemically, the oil consists in large part of the bihydrate of cajputene, from which cajputene having a hyacinthine odour can be obtained by distillation from anhydrous phosphoric acid. Like other volatile oils, the cajeput is a powerful stimulant, and is used medicinally where such medicines are required. Some practitioners have given it a high character as a remedy for cholera; but it does not appear to have any claim as a specific in the treatment of that disease. The dose taken internally as a stimulant, antispasmodic, and diaphoretic, is about five drops. It is used externally as a rubefacient, and is also resorted to occasionally with advantage in toothache. The oil from some species of *Eucalyptus* bears a close resemblance in odour and properties to cajeput.

CAJETAN, CARDINAL (1469–1534), was born at Cajeta in the kingdom of Naples in 1469. His proper name was Thomas de Vio, but he adopted that of Cajetan from his birthplace. He entered the order of the Dominicans at the age of sixteen, was for some time professor of divinity, and in 1508 became general of the order. For his zeal in defending the Papal pretensions, in a work entitled *Of the Power of the Pope*, he obtained the bishopric of Cajeta He was afterwards raised to the archiepiscopal see of Palermo, and in 1517 was made a cardinal by Leo X. The year following he went as legate into Germany, to quiet the commotions raised by Luther against indulgences; but the Reformer, under protection of Frederick elector of Saxony, set him at defiance; for though he obeyed the cardinal's summons in repairing to Augsburg, yet he rendered all his proceedings ineffectual. Cajetan was employed in several other negotiations and transactions, being as able in business as in letters. He died in 1534. He wrote commentaries upon portions of Aristotle, and upon the *Summa* of Aquinas, and made a careful translation of the Old and New Testaments, excepting Solomon's Song, the Prophets, and the Revelation of St John.

CALABAR is a district of somewhat indefinite boundaries, situated on the West Coast of Africa, in the Bight of Biafra, between 4° 20′ and 6° N. lat., and between 6° 30′ and 9° E. long. The name corresponds to no geographical or political unity, but is convenient as provisionally comprehending a stretch of country of considerable commercial importance. The coast line is frequently regarded as extending from the Nun mouth of the Niger, to the neighbourhood of the Cameroon Mountains, and thus includes the estuaries of the Brass River or Tuwon-Toro, the San Nicholas or Kola Toro, the New Calabar, and the Bonny, which are all deltaic branches of the Niger, as well as the San Pedro or Kan Toro, and the important embouchure of the united streams of the Cross River, the Old Calabar, and the Great Qua River. The interior of the country is still unexplored, and the inland boundary is left completely vague. The soil of the whole country, for 150 miles or further from the sea, is purely alluvial; and the surface is literally covered with bush except in the very limited areas under cultivation. Further inland, especially in the direction of the Cameroon Mountains, the elevation increases, the soil becomes more varied and decidedly rocky, and the forest grows clearer of underwood. This higher region is rich in natural productions, furnishing—besides the palm-oil which forms the main article of foreign trade on the coast—ebony, bamboos, sugar, pepper, yams, Indian corn, plantains, and a variety of woods.

Leaving the western portion which belongs to the delta of the Niger for treatment in the article on that river, we will confine our attention here to the district watered by the Old Calabar, the Cross River, and the Qua, which more particularly deserves the name of Calabar. The common estuary of these three rivers enters the ocean about 5° N. lat. and 8° 20′ E. long. It is about 10 or 12 miles wide at its mouth, and maintains nearly the same width for about thirty miles above the bar. At the junction with the Cross River the Old Calabar forms quite a labyrinth of channels and islands, and it is also united with the Qua by a number of creeks.

The exact position of the sources of these rivers has never been ascertained, but, according to native report, that of the Old Calabar is situated in the neighbourhood of Iko, which is not very far beyond Uyanga, the furthest point inland reached by Captain Hopkins and the Rev. Samuel Edgerley in their journey of exploration in 1872. The truth of this report is rendered almost certain by the diminished size of the stream in the vicinity of Uyanga; and it is thus probable that the mountains in which both it and its sister streams take their rise are the Rimsby range, forming a western extension of the Cameroons. The Qua River is comparatively small, and navigation is impeded, at no great distance up, by sand-banks and fallen trees. Further inland its course is also broken by rapids and several cataracts.

The country watered by these rivers is occupied by a great number of separate tribes, such as the Efik, the Ekoi, the Ibami, the Ököyöng, and the Aqua, who are politically independent of each other and speak separate languages. Of these the most important are the Efik, or people of Calabar in the strictest sense of that word, which was originally applied by the Portuguese discoverers to the tribes on the coast at the time of their arrival, when as yet the present inhabitants were unknown in the district. It was not till the early part of the 18th century that the Efik, owing to civil war with their kindred the Ibibio, migrated from the neighbourhood of the Niger to the shores of the Old Calabar, and established themselves at Ikoritungko or Creek Town. In order to get a better share in the European trade at the mouth of the river a body of colonists from this city migrated further down and built Obutöng or Old Town, and shortly afterwards a rival colony established itself at Aqua Akpa or Duke Town.

For a time it seemed as if Creek Town would disappear before its younger competitors, but it was again raised to power by King Eyo Eyo, who defied the interference of his rivals. The only political bond of union between the various towns is the Egbo, a kind of secret society into which admittance is obtained on the payment of a certain fee to each of the existing members. The power of this association is almost unlimited, and is used principally for the benefit of its members. Formerly it was one of the greatest curses of the country, from the barbarous customs mingled with its rites; but it is, under European direction, being turned into a means of promulgating a more civilized code of laws through the various towns, and it forms a kind of constitutional defence against the despotism of individual kings. However unsatisfactory the condition of the country still is, there is no doubt European influence of a beneficial kind is gradually making itself felt. The universal belief in the most terrible kinds of witchcraft is slowly being shaken; the use of the esere or Calabar bean as an ordeal, and for purposes of religious purgation, is becoming much less frequent; the murder of twin children is no longer a national custom; and the massacre of his slaves on the death of a king has been abolished. The present king of Creek Town is at least nominally a Christian; and, according to Consul Livingstone, "hundreds

of decently-dressed natives of both sexes regularly attend divine service" at the mission stations. These number five or six, and are supported by the United Presbyterian Church of Scotland, which began its labours here in 1846.

The predominant language, not only among the people of Calabar proper, but also of the various tribes on both sides of the Cross River, is Efik, which bids fair to be the common commercial speech of the whole district. It is really a modified Ibibio, and presents traces of what is known as alliterative concord, though this is by no means a universal characteristic. It has been reduced to writing by the missionaries, who have employed the ordinary English alphabet. Considerable progress has been made in the formation of an initiatory literature; no fewer than 65 volumes having proceeded from the mission press. Most important of these are the Efik translation of the New Testament by H. Goldie (1862), the translation of the Old Testament by Dr A. Robb (1868), and a Dictionary of the Efik by H. Goldie, published in 1862. Captain James Broom Walker of Duke Town, who has explored various parts of the country, presented several charts to the Royal Geographical Society, which are reproduced in the *United Presbyterian Missionary Record* for 1872 and 1875.

See Hope M. Waddell, *Twenty-nine Years in the West Indies and Central Africa*, 1866; "Details of Explorations of the Old Calabar River," by Captain Becroft in *Journ. Roy. Geogr. Soc.*, 1844; W. Nicholas Thomas in *Proceed. of Roy. Geogr. Soc.* on "The Oil Rivers of West Africa," 1873.

CALABAR BEAN, the seed of a leguminous plant, *Physostigma venenosum*, a native of tropical Africa. The plant has a climbing habit like the scarlet runner, and attains a height of about 50 feet, with a stem an inch or two in thickness. The seed pods, which contain two or three seeds or beans, are 6 or 7 inches in length; and the beans are about the size of an ordinary horse bean but much thicker, with a deep chocolate brown colour. They constitute the E-ser-e or ordeal beans of the negroes of Old Calabar, being administered to persons accused of witchcraft or other crimes. In cases where the poisonous material did its deadly work it was held at once to indicate and rightly to punish guilt; but when it was rejected by the stomach of the accused, innocence was held to be satisfactorily established. A form of duelling with the seeds is also known among the natives, in which the two opponents divide a bean, each eating one-half; that quantity has been known to kill both adversaries. Although thus highly poisonous, the bean has nothing in external aspect, taste, or smell to distinguish it from any harmless leguminous seed, and very disastrous effects have resulted from its being incautiously left in the way of children. The beans were first introduced into England in the year 1840; but the plant was not accurately described till 1861, and its physiological effects were investigated in 1863 by Dr Thomas R. Fraser. In that year an alkaloid was isolated from the seeds to which the name physostigmine was applied; and under the name eserine another alkaloid was prepared from them; but it is not yet quite certain that the two substances are essentially different. Dr Fraser's investigations, which were conducted with an alcoholic extract of the seeds, showed that the active principles exerted a remarkable influence in contracting the pupil of the eye, and in counteracting the influence of atropine. The antagonism of physostigmine and atropine and its relations to many other alkaloids have subsequently been the subject of very numerous investigations. A committee of the British Medical Association under Professor Hughes Bennett found that the antagonism between sulphate of atropine and extract of Calabar bean exists only within narrow limits, so that for practical purposes atropine is useless as an antidote to Calabar bean. The investigation of the same committee into the relations of hydrate of chloral and Calabar bean, however, proves that they are mutually antagonistic, but as the toxic influence of the Calabar bean is very rapid, it is necessary to administer the chloral as soon as possible after the Calabar bean is taken. Calabar bean in the form of powder and extract is used in medical practice. It has been chiefly employed by ophthalmists to produce contraction of the pupil, but it is also used in tetanus, neuralgia, and rheumatic diseases.

CALABOZO, or CALABOSO, a town of Venezuela, formerly capital of the province of Caracas, but now of that of Guarico, is situated 120 miles S.S.W. of the city of Caracas on the left bank of the River Guarico. It lies so low that during the rainy season it is frequently surrounded by the floods; and in the summer it is exposed to extreme heat, the average temperature being 88° Fahr. It is well built, with streets running at right angles, and it has several fine churches, a college, and public schools. Its situation on the main road from Aragua to Apure makes it the seat of a considerable trade; and the surrounding country affords extensive pasture for cattle. There are thermal springs in the neighbourhood. Originally a small Indian village, Calabozo owes its existence as a town to the Compania Guipuzcoana, who made it the seat of one of their mercantile stations in the beginning of the 18th century. In 1820 it was the scene of a battle in which Bolivar and Paez beat the Spanish general Morales. Population in 1873, 5618.

CALABRIA, the name given by the Romans to the peninsula at the south-eastern extremity of Italy, and now given to the peninsula at the south-western extremity. The former district was called by the Greeks Iapygia and Messapia, though these terms were variously used, and sometimes also included all the south-east of Italy, from Lucania to the Garganian promontory. In the time of Augustus, Calabria was the district south and east of a line drawn from the neighbourhood of Tarentum to that of Brundisium, corresponding to the modern Terra d'Otranto. The principal cities were Tarentum (Taranto), Brundisium (Brindisi), and Hydruntum (Otranto), all of which are ports. The inhabitants were Sallentines and Calabrians or Messapians, both probably of Pre-Hellenic or Pelasgic race; Niebuhr, however, considered the Calabrians to be Oscan intruders distinct from the other tribes.

Ancient Calàbria was a country of low hills with very gentle ascents, having a soil of Tertiary limestone formation, no rivers, and scarcely any small streams, and, during summer, a climate of intolerable heat, but exceedingly fertile, producing the olive and vine.

Owing to its position Calabria was long defended by the Greeks against the Goths, Lombards, and Saracens, and was the last portion of Italy lost by the Byzantine emperors in the 11th century. In the time of the Norman monarchy there took place a curious change in the application of the name, the cause and exact date of which are not known with any certainty. An explanation possessing some probability is, however, given. The Byzantines, it is likely, extended the name Calabria to all their possessions in Southern Italy; and when their possessions in the south-eastern peninsula became greatly inferior in importance to that in the south-western (Bruttium) they applied the name to the latter instead of the former. It was not, however, till after the Norman Conquest that the name was universally employed in this the modern sense.

In modern times Calabria, until the consolidation of the Italian kingdom, was the name of one of the four provinces into which the continental part of the kingdom of Naples, or of the Two Sicilies, was formerly divided; and it is now the name given to three out of the sixty-nine provinces of the present division of Italy. It is the most southerly

of Italy, being bounded on the N. by the province of Basilicata, on the E. by the Gulf of Taranto, on the W. by the Tyrrhenian Sea, and on the S. by the Ionian. It extends from Cape Spartivento (37° 56′ N. lat.) to Monte Pollino on the southern border of Basilicata (40° 0′ N. lat.)

The territory is well watered, and exceedingly rugged and mountainous; but the summits of the hills are covered with extensive forests of oak, beech, elm, and pine, and towards the coast the branches of the Apennines open up into fertile valleys. Earthquakes and violent storms are very common; and there is extreme heat during the summer season, on the approach of which the wealthier inhabitants migrate annually to the lofty table-land of La Sila, where their flocks are fattened in the extensive pastures. The agriculture of Calabria is in a very rude and barbarous condition, a circumstance which is partly attributable to the extreme fertility of the soil. The principal productions are corn, wine, raw silk, olive oil of an inferior quality, cotton, rice, liquorice, and saffron. Manna, collected from the manna-ash (*Ornus rotundifolia*), was at one time a somewhat important article of commerce; but very little is now collected. Oranges, lemons, figs, mulberries, honey, and tobacco are also produced. The horses of Calabria are remarkable for their high spirit and compact form. There are considerable fisheries of the tunny, the swordfish, the anchovy, and mullet.

The three provinces into which Calabria is now divided are Calabria Citeriore, Calabria Ulteriore Seconda, and Calabria Ulteriore Prima.

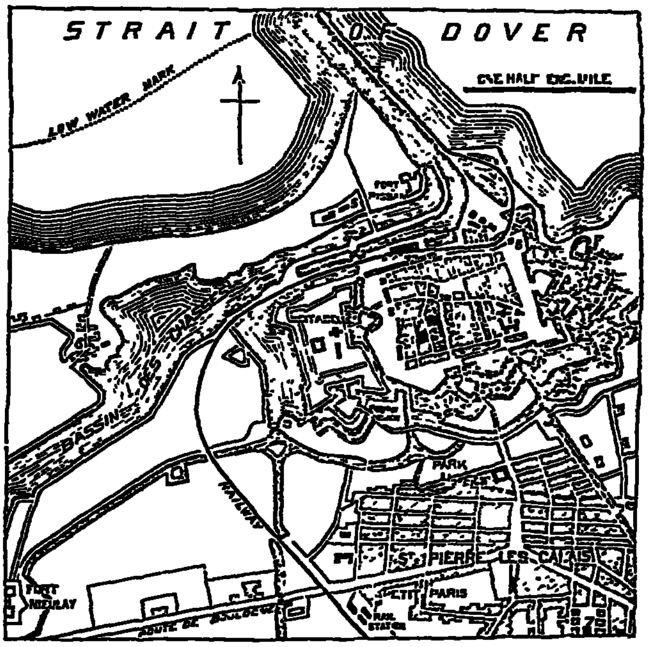
Calabria Citeriore, or Cosenza, is the most northern of the three provinces, and has an area of 2613 square miles, with a population in 1871 of 440,468. The southern and central districts are covered by the vast forests of La Sila, which furnished timber for the navies of antiquity. The principal rivers are the Crati, which after a course of 60 miles falls into the Gulf of Taranto, and the Neto, which rises in the heart of La Sila, and falls into the Adriatic. The principal towns are Cosenza, Rossano, Paola, and Castrovillari.

Calabria Ulteriore Seconda, or Catanzaro, on the south of Calabria Citra, having a coast line from the Punta dell' Alice to the Callipari on the east, and from the Savuto to the mouth of the Messina on the west, has an area of 2100 square miles. Population (1871) 412,226. At Catanzaro is a manufactory of silk; at Maida there are some seams of coal, antimony, and alabaster, which might be made available for exports. The principal towns are Catanzaro, Cotrone, Nicastro, and Monteleone.

Calabria Ulteriore Prima, or Reggio, the most southerly province of Italy, contains an area of 1250 square miles, with a population (1871) of 353,608. On the northern frontier are the mines of Lo Stilo, from which the iron is obtained for the Government foundries. The principal towns are Reggio, Gerace, and Palmi. A railway line now runs from Reggio to Taranto, along the coast of the Ionian Sea and the Gulf of Taranto.

CALAHORRA, the capital of the judicial district and diocese of the same name, in the province of Logroño, Spain, 24 miles S.E. of Logroño, in 42° 12′ N. lat., 2° 0′ W. long. It occupies an elevated site on the left bank of the River Cidacos, near its junction with the Ebro, and contains a cathedral in the mixed Gothic style, dating mainly from the 15th century, an episcopal palace, and several conventual and other schools. The climate is cold and damp, but the soil in the neighbourhood produces in abundance grain, pulse, flax, wine, and oil. Population in 1860, 7106. Calahorra is the ancient *Calagurris Nassica*, celebrated for its extraordinary fidelity to Sertorius in his war with Pompey and Metellus; and in the suburbs may still be traced the remains of an ancient Roman circus, an aqueduct, and a naumachia. Under the empire it was a municipium, and enjoyed the rights of Roman citizenship. It was the birthplace of Quintilian.

CALAIS, a town of France, capital of a canton of the same name, in the arrondissement of Boulogne and the department of Pas de Calais, 26 miles E.S.E. of Dover, and 185 miles by rail from Paris, in 50° 57′ 45″ N. lat., 1° 51′ E. long. Calais is a fortress of the first class, and was formerly a place of great strength, but it would now probably not be able to defend itself long against modern artillery. It is built in a rectangular form, having one of its longer sides towards the sea, while on the E. and S. it is surrounded by low and marshy ground which can be flooded to strengthen its defences. Overlooking the town on the W. is the citadel, erected in 1641 by Cardinal



Plan of Calais.

1. Church of Nôtre-Dame.
2. Church of the Courgain.
3. Hotel de Ville and Place de l'Armée.
4. Museum and Theatre
5. Bathing establishment.
6. Lighthouse.
7. Hotel de Ville de St Pierre les Calais.

Richelieu. In the centre of the town is the great market-place, in which stands the Hôtel de Ville (rebuilt in 1740, restored in 1867), with busts of Eustache de St Pierre, the Duc de Guise, and Cardinal Richelieu. Near the Hôtel de Ville is the *Tour du guet*, or watch-tower, used as a lighthouse until 1848. The Church of Nôtre Dame was almost entirely rebuilt at the end of the 15th century, during the English occupancy of Calais; its lofty tower serves as a landmark for sailors. At the end of the Rue de la Prison is the Hôtel de Guise, built as a guildhall for the English woolstaplers. It was given to the Duc de Guise as a reward for the recapture of Calais, and hence its name. The building which was formerly the Hôtel Dessin, immortalized by Sterne in the *Sentimental Journey*, is now used as a museum. The harbour of Calais is shallow, admitting vessels of from 400 to 500 tons only at high water. The French Government contemplates the construction of a large harbour of refuge near Calais. There are two lighthouses at the entrance to the harbour, and a still larger one on the fortifications, with a revolving light visible 20 miles off. The principal institutions are the schools of design, hydrography, and artillery, a public library with 10,000 volumes, and public baths. The imports are chiefly from Great Britain, and consist of coal, iron, woollen and cotton fabrics, linen, skins, machinery, and colonial produce. Of late years the importation of timber

from Norway has greatly increased. The exports comprise corn, wine and spirits, eggs, silk, fruit, vegetables, glass, and sugar. The fisheries are much less important than those of Boulogne. The manufacture of *tulle* or bobbin-net was introduced from Nottingham by the English in 1818, and is one of the main sources of the prosperity of the town and suburbs. Calais communicates with Great Britain by submarine telegraph, laid down in 1851. Steamers carrying the mails cross twice a day to Dover and back. It is the principal landing-place for English travellers on the Continent. The number of passengers who crossed both ways was 208,432 in 1875, being an increase of 66 per cent. in the last ten years. The terminus of the proposed tunnel beneath the channel is near Sangatte, a village six miles west of Calais. The project has received the sanction of the French and English Governments. Population (in 1872) 12,843; the adjoining manufacturing suburb of St Pierre les Calais had 20,409 inhabitants in 1872, more than 1800 of whom were English.

Calais was a petty fishing-village, with a natural harbour at the mouth of a stream, till the end of the 10th century. It was first improved by Baldwin IV., count of Flanders, in 997, and afterwards, in 1224, was regularly fortified by Phillip of France, count of Boulogne. It was besieged in 1346, after the battle of Crécy, by Edward III., and held out resolutely by the bravery of Jean de Vienne, its governor, till famine forced it to surrender. Its inhabitants were saved from the cruel fate with which Edward menaced them by the devotion of Eustache de St Pierre and six of the chief citizens, who were themselves spared at the prayer of Queen Philippa. The city remained in the hands of the English till 1558, when it was taken by the duke of Guise at the head of 30,000 men, from the ill-provided English garrison only 800 strong, after a siege of seven days. It was held by the Spaniards from 1595 to 1598, but was restored to France by the treaty of Vervins.

CALAMIS. See ARCHÆOLOGY, vol. ii. p. 354.

CALAMY, EDMUND (1600–1666), a Presbyterian divine, was born at London in February 1600, and educated at Pembroke Hall, Cambridge, where his opposition to the Arminian party, then powerful in that society, excluded him from a fellowship. Dr Felton, bishop of Ely, however, made him his chaplain, and gave him a living which he held till 1626. He then removed to Bury St Edmunds, where he acted as lecturer for ten years. In 1636 he was appointed to the rectory of Rochford in Essex, which was so unhealthy that he had soon to leave it; and in 1639 he was chosen minister of St Mary Aldermanbury in London. Upon the opening of the Long Parliament he distinguished himself in defence of the Presbyterian cause, and had a principal share in writing the work commonly known under the appellation *Smectymnuus*, against Episcopacy. The initials of the names of the several contributors formed the name under which it was published, viz., S. Marshal, E. Calamy, T. Young, M. Newcomen, and W. Spurstow. Calamy was afterwards an active member in the assembly of divines, and a strenuous opposer of sectaries. In Cromwell's time he lived privately, but was assiduous in promoting the king's return; for this he was afterwards offered a bishopric, but declined it. He was, however, made one of Charles's chaplains. He was ejected for nonconformity in 1662, and was so affected by the sight of the devastation caused by the great fire of London that he died shortly afterwards, October 29, 1666.

CALAMY, EDMUND (1671–1732), grandson of the preceding, was born in London, April 5, 1671. He was educated at a private academy, and studied at the university of Utrecht. While there, he declined an offer of a professor's chair in the university of Edinburgh made to him by Principal Carstairs, who had gone over on purpose to find a person properly qualified for such an office. After his return to England in 1691 he began to study divinity; and having joined the Nonconformists, he was in 1692 unanimously chosen assistant to Matthew Sylvester at Blackfriars. In 1694 he was ordained at Annesley's meeting-house in Little St Helen's, and soon afterwards was invited to become assistant to Daniel Williams in Hand-Alley. In 1702 he was chosen one of the lecturers in Salters' Hall, and in 1703 he succeeded Vincent Alsop as pastor of a large congregation in Westminster. He drew up the table of contents to *Baxter's History of his Life and Times*, which was sent to the press in 1696; made some remarks on the work itself, and added to it an index, and, reflecting on the usefulness of the book, he saw the expediency of continuing it, as Baxter's history came no farther than the year 1684. Accordingly, he composed an abridgment of it, with an account of many other ministers who were ejected after the restoration of Charles II.; their apology, containing the grounds of their nonconformity and practice as to stated and occasional communion with the Church of England; and a continuation of their history until the year 1691. This work was published in 1702. He afterwards published a moderate defence of nonconformity, in three tracts, in answer to some tracts of Dr Hoadly. In 1709 Calamy made a tour to Scotland, and had the degree of doctor of divinity conferred on him by the universities of Edinburgh, Aberdeen, and Glasgow. In 1713 he published a second edition of his *Abridgment of Baxter's History of his Life and Times*, in which, among various additions, there is a continuation of the history through the reigns of William and Anne, down to the passing of the Occasional Bill. At the end is subjoined the reformed liturgy, which was drawn up and presented to the bishops in 1661. In 1718 he wrote a vindication of his grandfather and several other persons against certain reflections cast upon them by Archdeacon Echard in his History of England; and in 1728 appeared his continuation of the account of the ministers, lecturers, masters, and fellows of colleges, and schoolmasters, who were ejected, after the Restoration in 1660, by or before the Act of Uniformity. He died June 3, 1732. Besides the pieces already mentioned, he published many occasional sermons.

CALAS, JEAN (1698–1762), a Protestant merchant at Toulouse, who was barbarously murdered under forms of law which were employed to shelter the sanguinary dictates of ignorant and fanatical zeal. He was born at La Caparède, in Languedoc, in 1698, and had lived forty years at Toulouse. His wife was an Englishwoman of French extraction. They had three sons and three daughters. His son Louis had embraced the Roman Catholic faith through the persuasions of a female domestic who had lived thirty years in the family. In October 1761 the family consisted of Calas, his wife, Marc-Antoine their son, who had been educated for the bar, Pierre their second son, and this domestic. Antoine being of a melancholy turn of mind, was continually dwelling on passages from authors on the subject of suicide, and one night in that month he hanged himself in his father's warehouse. The crowd, which collected on so shocking a discovery, took up the idea that he had been strangled by the family to prevent him from changing his religion, and that this was a common practice among Protestants. The officers of justice adopted the popular tale, and were supplied by the mob with what they accepted as conclusive evidence of the fact. The fraternity of White Penitents buried the body with great ceremony, and performed a solemn service for the deceased as a martyr; the Franciscans followed their example; and these formalities led to the popular belief in the guilt of the unhappy family.

Being all condemned to the rack in order to extort confession, they appealed to the parliament; but this body, being as weak as the subordinate magistrates, sentenced the father to the torture, ordinary and extraordinary, to be broken alive upon the wheel, and then to be burnt to ashes; which diabolical decree was carried into execution on the 9th of March 1762. Pierre Calas, the surviving son, was banished for life; the rest were acquitted. The distracted widow, however, found some friends, and among them Voltaire, who laid her case before the council of state at Versailles; and the parliament of Toulouse was ordered to transmit the proceedings. These the king and council unanimously agreed to annul; the chief magistrate of Toulouse was degraded and fined; old Calas was declared to have been innocent; and every imputation of guilt was removed from the family. See *Causes Célèbres*, tom. iv.

CALASIO, MARIO DE (1550–1620), a Franciscan, and professor of the Hebrew language at Rome, was born in 1550 at a small town in Abruzzo, from which he took his name. His *Concordance of the Bible* (which occupied him forty years) was published at Rome in 1621, the year after his death. This work has been highly approved and commended both by Protestants and Roman Catholics, and is indeed an admirable work; for, besides the Hebrew words of the Bible, which compose the body of the book, with the Latin version over against them, there are in the margin the differences between the Septuagint version and the Vulgate; so that at one view may be seen wherein the three Bibles agree, and wherein they differ. At the beginning of every article there is a kind of dictionary, which gives the signification of each Hebrew word, affords an opportunity of comparing it with other Oriental languages (Syriac, Arabic, and Chaldee), and is extremely useful for determining more exactly the true meaning of the Hebrew words. It has been several times reprinted; but the original edition is the best.

CALATAFIMI, a town of Sicily, in the province of Trapani and district of Alcamo, about 30 miles from Palermo. It lies between two hills in a fine corn country, and is celebrated for its cattle and its cheese In one of its churches, Santa Croce, there is a fine altar of mosaic work; and in the neighbourhood are the extensive and well-preserved ruins of Segesta. On the hill above the town stands the Saracenic castle of Kalat-al-Fimi, from which it derives its name, and about four miles distant is the battle-field on which Garibaldi won his first victory over the Neapolitans on May 15, 1860. Population, 9414.

CALATAYUD, a town of Spain, in the province of Saragossa in Aragon, 45 miles S.W. of the city of that name, in 41° 24′ N. lat., 1° 35′ W. long. It stands on the left bank of the River Jalon, near its confluence with the Jiloca, partly on the plain and partly on a rocky slope, which is covered with remains of ancient Moorish fortifications. It is generally spacious and well built, and contains several squares, the largest of which is used as the market-place, numerous convents, three hospitals, a fort, a provincial and municipal hall, an episcopal palace, a college, barracks, a theatre, and a bull-arena; there are also two *collegiatas*, or collegiate churches, both of them handsome edifices, and eleven other parish churches. The principal articles of manufacture are coarse brown paper, leather, and woollen stuffs. The soil of the neighbourhood is fertile and well cultivated. Calatayud is a Moorish city, and receives its name (Job's Castle) from Job the nephew of Musa; but it stands near the site of the ancient *Bilbilis*, the birthplace of the poet Martial, and was for the most part built out of its ruins. Population, 9830.

CALCAR, or KALCKER, JOHN DE (1499–1546), an eminent painter, born at Calcar, in the duchy of Clèves, in 1499. He was a disciple of Titian at Venice, and perfected himself by studying Raffaelle. He imitated those masters with such success as to deceive the most skilful critics. Among his various pieces is a Nativity, representing the angels around the infant Christ, which he arranged so that the light emanated wholly from the child. He died at Naples in 1546.

CALC-SPAR, or CALCAREOUS SPAR, is the popular name for certain of the crystalline forms of carbonate of lime or calcite ($CaCO_3$), containing in 100 parts 56 of lime and 44 of carbonic acid. The name includes only the varieties of calcite which belong to the rhombohedral or hexagonal order, to the exclusion of aragonite, which, having the same composition, belongs to the rhombic or right prismatic system, the two minerals forming a striking example of dimorphism. Calc-spar is also the same in chemical composition as marble, limestone, chalk, stalagmitic deposits, &c., which are among the most abundant ingredients in the rocky masses of the earth. The primary form of calc-spar is an obtuse rhombohedron, the faces of which are inclined to each other in the terminal edges at an angle of 105°·5, and all secondary crystals, however various they may be, tend to break or split up into that primary form. The variety of crystalline forms assumed by the mineral is exceedingly great, upwards of 800 being enumerated, of which 700 have been figured by Count Bournon in his treatise on carbonate of lime. The forms, although thus numerous, fall chiefly under the two heads of rhombohedrons, of which Iceland spar is a type, and scalenohedrons, which may be represented by the variety known as dog's-tooth spar. (See MINERALOGY.) Pure calc-spar is a transparent, colourless mineral with a vitreous lustre; its specific gravity is about 2·721; and in hardness it is intermediate between gypsum and fluor-spar, occupying the third place in the standard scale. It is frequently tinted in red, yellow, green, brown, and grey, from the presence of foreign matter. Pure, transparent rhombohedral crystals, obtained by cleavage or otherwise, are distinguished as Iceland spar, on account of the largest and finest crystals being found in that island, or as doubly-refracting spar (German, *Doppelspath*), from their exhibiting in the highest degree the double refraction of light. Before the blow-pipe it is reduced to caustic lime, and moistened with hydrochloric or other acid it displays a brisk effervescence. It occurs abundantly in almost all parts of the world,—Andreasberg in the Hartz and the Derbyshire lead mines being noted localities for large fine crystals. Magnificent cleavage rhombohedrons are obtained from Iceland, one having been noted which exceeded 6 yards long and 3 yards high. Professor Dana notices one nearly transparent crystal, weighing 165 lb, now in the cabinet of Yale College, found in the Rossie Lead Mine, New York State, and he cites a large number of other localities in the United States where crystals occur. Iceland spar, on account of its high double refracting property, is very extensively employed in optical research. It is most conveniently used in the form of a Nicol's prism, which consists of a long rhomboidal crystal cut obliquely into two equal portions in a plane perpendicular to the plane of the longer diagonal of the base. The two halves are cemented together in their original position with Canada balsam; and in this condition the ordinary ray undergoes total reflection from the prism, whilst the extraordinary ray passes through.

CALCHAS, the most famous soothsayer among the Greeks at the time of the Trojan war, was the son of Thestor. He foretold to the Greeks the length of time they would be engaged in the siege of Troy, and when the fleet was detained by adverse winds, at Aulis, he explained the cause and demanded the sacrifice of Iphigenia. When the Greeks were visited with pestilence on account of Chryseis, he disclosed to them the reasons of Apollo's

anger. After the return of the Greeks from Troy he is said to have retired to Colophon. According to the story, his death was due to chagrin at being surpassed in a trial of soothsaying skill by one Mopsus. It had long been predicted that he should die whenever he met his superior in divination.

CALCULATING MACHINES. Mathematicians and astronomers have felt in all ages the irksomeness of the labour of making necessary calculations, and this has led to the invention of various devices for shortening it. Some of these, such as the Abacus, Napier's Bones (invented by the father of logarithms), and the modern Sliding Rule, are rather aids to calculation than calculating machines. Pascal is believed to have been the original inventor of a calculating machine; its use was limited to addition, multiplication, &c., of sums of money, and as it required the constant intervention of a human operator the results were subject to the ordinary errors of manipulation. After him came the celebrated Leibnitz, Dr Saunderson, who, blind from his childhood, became professor of mathematics in Cambridge, and others. But all their machines were completely cast into the shade by the wonderful inventions of the late Charles Babbage. He knew well the immense value that absolutely correct tables possess for the astronomer and the navigator, and that a machine which could produce them with speed was a very great desideratum. The first calculating machine he invented he called a difference engine, because it was to calculate tables of numbers by the method of differences. By setting at the outset a few figures the attendant would obtain by a mechanical operation a long series of numbers absolutely correct. The difference engine was not intended to answer special questions, but to calculate and then print numerical tables, such as logarithm tables, tables for the *Nautical Almanac*, &c. An interesting account of some of the errors which are found in what are considered reliable tables is given in a paper by Babbage in the *Memoirs of the Astronomical Society*, 1827.

Every numerical table consists of a series of numbers which continuously increase or diminish. As an example take the squares of the natural numbers, 1, 4, 9, 16, 25, 36, &c. Designate this series by N. If we subtract each term from the one following it we get a new series, 3, 5, 7, 9, &c., which is called the series of first differences; designate this by Δ^1. If in the same way we subtract each term of this series from the succeeding term, we get what is called the series of second differences, every term of which is in this instance 2. Designate this series by Δ^2. As the different series were obtained by subtraction, it is quite evident that by reversing the process we shall obtain the original table. Suppose we are given the first terms of N, Δ^1, and Δ^2, *i.e.*, 1, 3, 2. If we add 3, the first term of Δ^1, to 1, the first term of N, we get 4, the second term of N; and if we add 2, the first term of Δ^2, to 3, the first term of Δ^1, we get 5, the second term of Δ^1; and this added to 4, the second term of N, gives us 9, the third term of N. Similarly we obtain 16 by adding 9, 5, and 2 together, and 25 by adding 16, 7, and 2. Hence, given 1, 3, 2, we can, by a process of additions, obtain the series of square numbers. All numerical tables can be calculated entirely by this method or by repetitions of it.

Table of Square Numbers, N	First Differences, Δ^1	Second Differences, Δ^2
1	3	2
4	5	2
9	7	2
16	9	
25		

The main characteristics of the difference engine, designed and partially constructed by Babbage, are these:—It consisted of several vertical columns of figure-wheels like large "draught men" one above another, to the number of six in each column. The natural numbers from 0 to 9 were cut on the rims of the figure wheels; hence each figure-wheel in a column could represent a digit. Thus the lowest wheel gave the units digit, the second wheel the tens digit. The number 5703 would be represented on the wheels of a column as in the margin. The different columns were to represent the successive series of differences above referred to, and were called the table column, the first difference column, &c.

5
7
0
3

"The mechanism was so contrived that whatever might be the numbers placed respectively on the figure wheels of each of the different columns, the following succession of operations took place as long as the handle was moved. Whatever number was found upon the column of first differences, would be added to the number found upon the table column. The same first difference remaining upon its own column, the number found upon the column of second differences would be added to that first difference." Similarly for all the other columns. For example, suppose we are calculating the cubes of the natural numbers. At a certain stage of the work we would find 125 shown by the wheels of the table column, 91 by those of the first difference column, 36 by those of the second difference column, and 6 on the lowest wheel of the third difference column. On making a turn of the handle the 91 would be added to the 125, which would then show 216; at the same time 36 would be added to the 91, so that the first difference column would then show 127; moreover 6 would be simultaneously added to the 36, which would thus become 42, and the 6 would remain unaltered. Another turn and we would get 343, 169, 48, 6 on the different columns. Had the engine been completed it would have had columns for six orders of differences, each of twenty places of figures, whilst the first three columns would each have had half a dozen additional figures.

	Table Column.	First Difference Column.	Second Difference Column.	Third Difference Column.
	1 2 5	9 1	3 6	6
After one Turn ...	2 1 6	1 2 7	4 2	6
After two Turns...	3 4 3	1 6 9	4 8	6

It was about 1822 that Babbage having constructed a small model of his engine sent an account of it to Sir Humphrey Davy, then president of the Royal Society of London. Government heard of the invention, and, having received from the Royal Society a favourable report on the merits and utility of the engine, advanced money towards its construction. Sums of money were at irregular intervals voted for this purpose; but so great were the difficulties to be overcome, so entirely new even were many of the tools necessary, so much time was occupied in testing the value of each proposed contrivance, that in 1834 only a portion was completed. The construction of the machine here stopped, although the Royal Society had again, in 1829, reported most favourably on the engine as regards its practicability, immense utility, and the progress it had made. The Government had already advanced £17,000 (over and above what Babbage had spent, besides giving his personal superintendence without any remuneration), and they saw no definite limit to the amount it would cost;

and Babbage had a delicacy in pressing for the completion of the difference engine, as he had recently designed a new machine, the analytical engine, which, if completed, would entirely supersede it. The portion completed is in King's College, London.

It will be noticed that the use of the difference engine was limited to the working of such problems as can be solved by successive additions or subtractions. The analytical engine, on the other hand, was designed to *work out* any problem that the superintendent knew *how* to solve. It consists of two parts, each of a number of vertical columns of figure wheels, similar to those of the difference engine; on the one set called the "variables," which we shall designate by V_1, V_2, &c., the numbers of the special problem or formula are placed; the other set is called the "mill," and performs the required operations of multiplication, division, addition, or subtraction. Its working was directed by means of two sets of cards—"operation" cards, which instructed the mill whether to multiply, divide, add, or subtract, and "variable" cards, which indicated to the mill the particular columns, *i.e.*, numbers on which it was to perform this operation. An example will make this clear. Suppose we wish to solve the equations

$$ax + by = c,$$
$$dx + fy = g.$$

On the wheels of V_1, the first column of the variables, the number a is placed, b on V_2, c on V_3, and so on. Six columns in all are required for this. It is evident that $x = \frac{fc - bg}{fa - bd}$. Hence, to get x, we require the products of f and c, b and g, &c. To get these the superintendent intimates to the mill by means of an "operation" card that a multiplication is to be performed, then points out by a "variable" card what are the two numbers, *i.e.*, the two columns to be multiplied, and on what column the result is to be placed. In the first case the columns indicated would be V_5, V_3, and V_7 respectively. By another operation card and another variable card, the mill would then be instructed to multiply the numbers on V_2 and V_6, and to place the result on V_8. Similarly ca and bd would be obtained on V_9 and V_{10}. The superintendent would then instruct the mill to subtract the number on V_8 from that on V_7, to place the result $(fc—bg)$ on V_{11}, and similarly, $fa—bd$ would be placed on V_{12}. By a new operation card the mill would now be put into a "dividing" state, and a variable card would tell it that V_{11} was to be divided by V_{12}, and the result given on V_{13}. This would be the value of x. Similarly for y. The number of cards can be greatly diminished. Thus, for the four multiplications one card would suffice. The cards are of pasteboard (say) and have holes punched in them,—a "multiplication" card having a certain number of holes bored in it and arranged in a particular way, a "division" card a different arrangement of holes, &c. The cards are so placed in the machine that certain levers drop through these holes, while others are unaffected, and the machinery in connection with the levers is put out of gear or not as is desired. In this way the mill is put into a condition in which it multiplies (say) the numbers indicated to it. The variable cards act in a similar manner. When an operation card and a variable card are given to the engine, the numbers on the assigned columns are transferred to the mill, the operation is performed, and the numbers and the result are placed on the proper columns. The series of cards used for any one problem would enable the machine to solve any other similar problem. Babbage says of the engine, "The analytical engine is therefore a machine of the most general nature. Whatever formula it is required to develop, the law of its development must be communicated to it by two sets of cards. When these have been placed the engine is special for that particular formula. The numerical constants must then be put on the wheels, and on setting the engine in motion it will calculate and print the numerical results of that formula." In the construction of this engine he overcame one of the greatest difficulties in such an instrument, that of effecting the carrying of tens. The engine was designed so as to foresee these carriages, and act upon that foresight, and thus a great reduction of the time necessary to make a given calculation was at once obtained by effecting all carriages simultaneously instead of in succession. He says of it, "The analytical engine will contain—1°, apparatus for printing on paper, one, or if required, two copies of its results; 2°, means for producing a stereotype mould of the table or results it computes. The engine would compute all the tables it would itself require. It would have the power of expressing every number to fifty places of figures." It would multiply two numbers of fifty figures each, and print the result in one minute. Its construction was never begun, but Babbage left complete plans of every part of it.

In the *Edinburgh Review* for July 1834 appeared an account of the principles of Babbage's difference engine. Herr George Schentz, a printer at Stockholm, read it, and shortly afterwards he and his son Edward set about constructing a calculating machine. By 1843 they produced one capable of calculating series with terms of five figures, with three orders of differences, also of five figures each, and of printing its results. Provided with a certificate to this effect from the Royal Swedish Academy of Sciences, they endeavoured unsuccessfully to get orders for their machine. In 1853, with the aid of grants from the Swedish Government, the Messrs Scheutz finished a second machine which was exhibited in England, and at the Paris exhibition of 1855. It eventually went to America. It was about the size of a small square pianoforte. It could calculate series with four orders of differences each of fifteen figures. It printed the results to eight figures, the last of which was capable of an automatic correction where necessary for those omitted. "It could calculate and stereotype without a chance of error two and a half pages of figures in the same time that a skilful compositor would take to set up the types for one single page."

A new machine by the Messrs Scheutz was constructed about 1860 by Messrs Donkin for the Registrar-General for the sum of £1200. It has been used in the calculation of some of the tables in the *English Life Table*, published in 1864. Dr Farr says of it, "The machine has been extensively tried, and it has upon the whole answered every expectation. But it is a delicate instrument, and requires considerable skill in the manipulation. It approaches infallibility in certain respects; but it is not infallible, except in very skilful hands. The weakest point is the printing apparatus, and that admits of evident improvement."

M. Staffel and M. Thomas (de Colmar) have invented machines which can perform addition, subtraction, multiplication, division, and extraction of the square root. M. Thomas's machine is extensively used.

Sir William Thomson has recently invented an instrument (no description of which has yet been printed) which is able to solve any linear differential equation with variable coefficients.

Professor Tait has also invented the principle of a machine, which, if constructed, will integrate any linear differential equation of the second order with variable coefficients.

See the article "Calculating Machines" in Walford's *Insurance Cyclopædia*, where many references will be found, and a translation of General Menambrea's article on Babbage's Analytical Engine in Taylor's *Scientific Memoirs*, vol. iii. (P. S. L.)

CALCULUS. See DIFFERENTIAL AND INTEGRAL CALCULUS.

CALCUTTA, the capital of India, and seat of the Supreme Government, is situated on the east bank of the Húglí River, in latitude 22° 33′ 47″ N. and longitude 88° 23′ 34″ E. It lies about 80 miles from the seaboard, and receives the accumulated produce which the two great river systems of the Ganges and the Brahmaputra collect throughout the provinces of Bengal and Assam. From a cluster of mud villages at the close of the 17th century, it has advanced with a rapid growth to a densely inhabited metropolis, which, with its four suburbs, contains a population of 892,429 souls. The central portion, which forms the Calcutta municipality, has a population returned in 1872 at 447,601. In the same year its maritime trade amounted to $52\frac{1}{2}$ millions sterling, of which the exports formed $31\frac{3}{4}$ millions, and the imports $20\frac{3}{4}$, showing an excess of exports over imports of 11 millions sterling.

The history of Calcutta practically dates from the year 1686. In 1596 it had obtained a brief entry as a rent-paying village in the survey of Bengal executed by command of the Emperor Akbar. But it was not till 90 years later that it emerged into history. In 1686 the English merchants at Húglí, finding themselves compelled to quit their factory in consequence of a rupture with the Mughul authorities, retreated about 26 miles down the river to Sutánatí, a village on the banks of the Húglí, now within the boundaries of Calcutta. Their new settlement soon extended itself along the river bank to the then village of Calcutta, and by degrees the cluster of neighbouring hamlets grew into the present town. In 1689–90 the Bengal servants of the East India Company determined to make it their headquarters. In 1696 they built the original Fort William, and in 1700 they formally purchased the three villages of Sutánatí, Calcutta, and Gobíndpur from Prince Azim, son of the Emperor Aurungzebe.

The site thus chosen had an excellent anchorage, and was defended by the river from the Marhattás, who harried the districts on the other side. A fort, subsequently rebuilt on the Vauban principle, and a moat,

Ground-Plan of Calcutta.

1. Almshouses.
2. Leper Asylum.
3. Church Mission.
4. Catholic College.
5. Baptist Chapel and Mission.
6. St Thomas R C. Church.
7. Asiatic Society.
8. Small Cause Court.
9. Church (R.C.) of the Sacred Heart.
10. Mosque.
11. Baptist Chapel.
12. Home Department.
13. Treasury.
14. Town Hall.
15. Supreme Court
16. Bank of Bengal.
17. Stationery Office.
18. Metcalf Hall.
19. St John's Church
20. Foreign Department.
21. New Post Office.
22. Sudder Dewanny Adalut.
23. Government Iron Bridge Yard.

designed to form a semicircle round the town, and to be connected at both ends with the river, but which was never completed, combined with the natural position of Calcutta to render it one of the safest places for trade in India during the expiring struggles of the Mughul empire. It grew up without any fixed plan, and with little regard to the sanitary arrangements required for a town. Some parts of it lie below water mark on the Húglí, and its low level throughout rendered its drainage a most difficult problem. Until far on in the last century, the jungle and paddy fields closely hemmed in the European mansions with a circle of malaria; the vast plain (*maidán*), with its gardens and promenades, where the fashion of Calcutta now displays itself every evening, was then a swamp during three months of each year; the spacious quadrangle known as Wellington Square was built upon a filthy creek. A legend relates how one-fourth of the European inhabitants perished in twelve months, and during seventy years the mortality was so great that the name of Calcutta, derived from the village of Kálighát, was identified by mariners with Golgotha, the place of a skull.

The chief event in the history of Calcutta is the sack of the town and the capture of Fort William in 1756, by Suráj-ud-Daulá, the Nawáb of Bengal. The majority of the English officials took ship and fled to the mouth of the Húglí River. The Europeans who remained were compelled, after a short resistance, to surrender themselves to the mercies of the young prince. The prisoners, numbering 146 persons, were driven at the point of the sword into the guard-room, a chamber scarcely 20 feet square, with but two small windows. Next morning only 23 were taken out alive, among them Mr Holwell, the annalist of the "Black Hole." This event took place on June 20, 1756. The Mahometans retained possession of Calcutta for about seven months, and during this brief period the

name of the town was changed in official documents to Alinagar. In January 1757 the expedition despatched from Madras, under the command of Admiral Watson and Colonel Clive, regained possession of the city. They found many of the houses of the English residents demolished, and others damaged by fire. The old church of St John's lay in ruins. The native portion of the town had also suffered much. Everything of value had been swept away, except the merchandise of the Company within the fort, which had been reserved for the Nawáb. The battle of Plassey was fought on June 23d, 1757, exactly twelve months after the capture of Calcutta. Mír Jáfar, the nominee of the English, was created Nawáb of Bengal, and by the treaty which raised him to this position he agreed to make restitution to the Calcutta merchants for their losses. The English received £500,000, the Hindus and Mahometans £200,000, and the Armenians £70,000. By another clause in this treaty the Company was permitted to establish a mint, the visible sign in India of territorial sovereignty, and the first coin, still bearing the name of the Delhi emperor, was issued on August 19th, 1757. The restitution money was divided among the sufferers by a committee of the most respectable inhabitants. Commerce rapidly revived, and the ruined city was rebuilt. Modern Calcutta dates from 1757. The old fort was abandoned, and its site devoted to the Customs House and other Government offices. A new fort, the present Fort William, was commenced by Clive, a short distance lower down the River Húglí. It was not finished till 1773, and is said to have cost two millions sterling. At this time also the *maidán*, the park of Calcutta, was formed; and the salubrity of its position induced the European inhabitants gradually to shift their dwellings eastward, and to occupy what is now the Chauringhi (Chowringhee) quarter.

From this time the history of Calcutta presents a smooth narrative of advancing prosperity. No outbreak of civil war nor any episode of disaster has disturbed its progress, nor have the calamities of the climate ever done mischief which could not be easily repaired. A great park (*maidán*), intersected by roads, and ornamented by a garden, stretches along the river bank. The fort rises from it on its western side, the stately mansions of Chauringhi with Government House, the high court, and other public offices, line its eastern and northern flank. Beyond the European quarter lie the densely populated clusters of huts or "villages" which compose the native city and suburbs. Several fine squares, with large reservoirs and gardens, adorn the city, and broad well-metalled streets connect its various extremities.

Up to 1707, when Calcutta was first declared a presidency, it had been dependent upon the older English settlement at Madras. From 1707 to 1773 the presidencies were maintained on a footing of equality; but in the latter year the Act of Parliament was passed, which provided that the presidency of Bengal should exercise a control over the other possessions of the Company; that the chief of that presidency should be styled Governor-General; and that a supreme court of judicature should be established at Calcutta. In the previous year, 1772, Warren Hastings had taken under the immediate management of the Company's servants the general administration of Bengal, which had hitherto been left in the hands of the old Mahometan officials, and had removed the treasury from Murshidábád to Calcutta. The latter town thus became the capital of Bengal, and the seat of the Supreme Government in India. In 1834 the Governor-General of Bengal was created Governor-General of India, and was permitted to appoint a Deputy-Governor to manage the affairs of Lower Bengal during his occasional absence. It was not until 1854 that a separate head was appointed for Bengal, who, under the style of Lieutenant-Governor, exercises the same powers in civil matters as those vested in the Governors in Council of Madras or Bombay, although subject to closer supervision by the Supreme Government. Calcutta is thus at present the seat both of the Supreme and the Local Government, each with an independent set of offices. Government House, the official residence of the Governor-General of India, or Viceroy, is a magnificent pile of buildings to the north of the fort and the *maidán*, built by Lord Wellesley in 1804. The official residence of the Lieutenant-Governor of Bengal is a house called Belvedere, in Alipur, the southern suburb of Calcutta. Proposals have been made from time to time to remove the seat of the Supreme Government from Calcutta. Its unhealthiness, especially in the rainy season, its remoteness from the centre of Hindustán, and its distance from England, have each been animadverted upon. These disadvantages of Calcutta have now, however, been almost entirely removed, or their consequences have been mitigated, by the conquests of science and modern engineering. The railway and the telegraph have brought the Viceroy at Calcutta into close contact with every corner of India; while an ample water supply, improved drainage, and other sanitary reforms, have rendered Calcutta the healthiest city in the East,—healthier, indeed, than some of the great European towns. English civilization has thus enabled Calcutta to remain the political capital of India. The same agency still secures the city in her monopoly of the sea-borne trade of Bengal. The River Húglí has long ceased to be the main channel of the Ganges; but Calcutta alone of all the successive river capitals of Bengal has overcome the difficulties incident to its position as a deltaic centre of commerce. Strenuous efforts of engineering are required to keep open the "Nadiyá Rivers," namely, the three off-shoots of the Ganges which combine to form the Húglí. Still greater watchfulness and more extensive operations are demanded by the Húglí itself below Calcutta, to save it from the fate of other deltaic streams, and prevent it from gradually silting up. In 1853 the deterioration of the Húglí channel led to a proposal to found an auxiliary port to Calcutta on the Matlah, another mouth of the Ganges. A committee, then appointed to inquire into the subject, reported that "the River Húglí was deteriorating gradually and progressively." At that time "science had done nothing to aid in facilities for navigation," but since then everything has been done which the foresight of modern knowledge could suggest, or the power of modern capital could achieve. Observations on the condition of the river are taken almost hourly, gigantic steam dredgers are continually at work, and the shifting of the shoals is carefully recorded. By these means the port of Calcutta has been kept open for ships of the largest tonnage, and now seems to have out-lived the danger which threatened it.

Statistics.—Calcutta may, in one sense, be said to extend across the Húglí, and to include Howrah on the western side of the river, as well as the three separate municipalities on the eastern bank, known as the suburbs of Calcutta, the north suburban town, and the south suburban town. The total *population* of the area thus defined was returned by the census of 1872 at 892,429 souls. Calcutta proper, or the central portion, which lies, roughly speaking, between the old Marhatta ditch and the Húglí, is governed by a distinct municipality. In 1752 Mr Holwell estimated the number of houses within its limits at 51,132, and the inhabitants at 409,056 persons; but both these estimates were probably much too high; in 1822 the number of inhabitants was returned at 179,917; in 1831 at 187,081; in 1850 at 361,369; and in 1866 at 377,924. In 1872 a regular census was taken under the conduct of the municipality. The results present features of doubtful accuracy. They were as follows:—Area, 8 square miles; number of houses, 38,864; population,—Hindus, 291,194; Mahometans, 133,131; Buddhists, 863; Christians, 21,356; "other" denominations not separately classified, 1031

grand total, 447,601; total of males of all denominations, 299,857; females, 147,744; average number of persons per house, 11; number of persons per square mile, 55,950. The length of the *roads* in the town is about 120 miles. The present *governing body* was created in accordance with the provisions of Act 6 of 1863 (Bengal Council). It consists of the justices of the peace for Calcutta, with a salaried chairman, who is a member of the civil service. All the members are nominated by the Government, but a deputy chairman is chosen by the justices out of their own body. As the justices are not in any sense representative, the power and responsibility are to a great extent centred in the chairman; but of late years, by means of departmental committees, the co-operation of the ordinary members has been enlisted. Out of about 100 justices who are resident in Calcutta exactly one-half are Europeans. In 1874 the ordinary revenue of the municipality amounted to £240,656, of which £160,000 was raised by rates, and £37,000 by licences. The ordinary expenditure for the same year amounted to £233,374, of which £80,000 was devoted to interest on loans and sinking fund, £32,000 to general expenses, £30,000 to roads, two items of £22,000 to lighting and water supply, and £13,000 to conservancy. Including capital account, receipts, loans, suspense account, and cash balances, the total amount at the disposal of the justices during the year was £433,938. The aggregate expenditure under both revenue and capital account amounted to £382,823. The total loan liabilities of the corporation are £1,466,060, and the total of interest and sinking fund payable yearly is £100,474. The average rate of municipal taxation per head of the population is about 10s. 8d. The most important undertaking under the care of the municipality is the *water supply*. The present system dates from 1865, when the sanction of Government was given to the construction of works which now pour upwards of 6 million gallons a day of filtered water into the city. The source of supply is from the Húglí at Palta, about 16 miles above Calcutta. The works there consist of two large suction pipes, 30 inches in diameter, through which the water is drawn from the river by three engines, each of 50 horse power nominal; the water is then passed into six settling tanks, each 500 feet long by 250 feet wide. Here it is allowed to stand for 36 hours, when it is permitted to run off to the filters, eight in number, the area of each being 200 by 100 feet. After filtration the water is made to flow over a marble platform, where its purity can be observed. It is then conducted to Calcutta by a 42-inch iron main. These works cost £525,432. They were finished in 1870, and connected with pipes laid under 100 miles of streets. The total number of house connections up to December 31, 1874, was 8159. The total quantity of water delivered during that year amounted to 2,524,566,300 gallons, being considerably over the estimated average of 6 million gallons daily, or about 13 gallons per head of the population. The total cost for the same year of the water-supply (inclusive of interest) was £55,547, or about 5d. per 1000 gallons.

The *drainage* works are on an equally effective scale. The main sewers are underground, and for the proper discharge of their contents in the direction of the Salt Lake, a pumping station is maintained at an annual cost of £3000. The system of underground drainage, although not entirely completed, had cost in 1874 a capital sum of £620,000 In 1863, on the constitution of the present municipality, a *health officer* with an adequate establishment was appointed The practice of throwing corpses into the river has been put down, and the burning *ghâts* and burial-grounds have been placed under supervision. All refuse and night-soil are removed by the municipality, and conveyed by a special railway to the Salt Lake. The town is lighted by a private *gas company*, 2723 gas lamps and 730 oil lamps being paid for at the public expense. The fire brigade consists of 2 steam fire-engines, and 5 hand engines, its annual cost being about £2000. The *police* of Calcutta is under the control of a commissioner, who is also the chairman of the justices Beneath him there is a deputy-commissioner. The force consists of 4 superintendents, 155 subordinate officers of various grades, 1292 constables, and 6 mounted constables, maintained in 1873 at a cost of £41,227, of which Government contributed one-fourth. Several minor bodies, such as the river police, Government guards, &c., bring the entire strength of the force in the town and on the river to 2313 men. The great majority are natives, the number of European sergeants and constables being only 50.

In 1872–73 the statistics of *education* in Calcutta were as follows:—There were 3 Government colleges, namely, the Presidency College, founded in 1855, and attended by 709 pupils; the Sanskrit College, established in 1824, attended by 26 adult pupils, of whom 17 are Bráhmans; the Calcutta Madrásá or Mahometan College founded in 1781, number of pupils 528. There are also five colleges mainly supported by missionary efforts, aided by Government, and attended by 305 pupils The total number of schools in Calcutta reported on by the Educational Department is 260, with 19,445 scholars; 157 of them are male schools, teaching 16,155 boys; the remaining 103 are for girls, and teach 3290 pupils. According to a different principle of classification, 36 schools teach English to 9445 boys, 121 teach the vernacular only to 6620 boys, 99 are vernacular schools for girls with 3244 pupils, and 4 are normal schools, instructing 90 male teachers and 46 female. Of the total number of pupils in these schools, 47·7 per cent. are ascertained to be Hindus, 13·5 Christians, 2·6 Musalmáns, and the remaining 36·2 per cent. are of unascertained religions. The total ascertained expenditure was £25,011, of which sum the Government contributed £9160. The Government School of Art was attended in 1872–73 by 94 students, of whom 88 are Hindus, 4 Musalmáns, and 2 Eurasians. Calcutta has also an important school of medicine, or medical college, with a large hospital attached and every facility for a thorough scientific training.

The *medical charities* of Calcutta comprise the Medical College Hospital, just named the General Hospital, the Native or Mayo Hospital, the Municipal Pauper Hospital, and minor dispensaries. Of these the General Hospital is confined almost solely to Europeans. The total amount contributed by Government to these institutions is £30,000. The number of persons treated during the year 1872–73 was 251,039, of whom 20,805 were indoor patients. Of these 64·9 per cent. were men, 16·3 women, and 18·8 children. The rate of mortality in cholera cases was 484·3 for every thousand treated.

Mortuary returns are collected in Calcutta by the police inspectors, and compared with the registers kept by paid clerks of the municipality at the burning *ghâts* and burial-grounds. In 1873 the total number of deaths thus ascertained was 11,557, or 25·32 per thousand. The death rate among the Christians was 31·5, among the Hindus 26·1, and among the Mahometans 24·7. The highest death rate was in January, November, and December, and the lowest in June and July.

The mean temperature of Calcutta is about 79° Fahr. The highest temperature recorded during the last 18 years is 106° in the shade, and the lowest 52°·7. The extreme range is therefore a little over 53°, while the mean temperatures of December and May, the coldest and hottest months, are 68°·5 and 85° respectively. The average rainfall during 36 years has been 66 inches,—the highest rainfall on record being 93·31 inches in 1871, and the lowest 43·61 inches in 1837. By far the greater part of the rain falls between the months of June and October.

Like the rest of the seaboard of the Bay of Bengal, Calcutta is exposed to periodical cyclones, which do much mischief. The greatest pressure of the wind registered is 50 lb to the square foot. In the storms of 1864 and 1867 the anemometer was blown away. A great loss of life and property was caused along the Húglí by the storm of October 5th 1864. In Calcutta and its suburbs 49 persons were killed, and 16 wounded, 102 brick houses were destroyed, and 563 severely damaged; 40,698 tiled and straw huts were levelled with the ground. The destruction of shipping in the port of Calcutta appears greatly to have exceeded that on record in any previous storm. Out of 195 vessels only 23 remained uninjured, and 31, with an aggregate tonnage of 27,653 tons, were totally wrecked. On November 2, 1867, the force of the wind was not less violent, but there was no storm wave, and consequently the amount of damage done was much less.

The Port of Calcutta, extending 10 miles along the Húglí, with an average width of working channel of 250 yards, and with moorings for 169 vessels, is under the management of a body of 9 European gentlemen styled "Commissioners for making Improvements in the Port of Calcutta." This body was constituted in 1870, and has since that date received considerable additions to its powers. In 1871 they were appointed "Bridge Commissioners," to take charge of the floating bridge over the Húglí, and to work it when completed. This bridge, finished in 1874, now supplies a permanent connection between Calcutta and the railway terminus on the Howrah side of the river. It is constructed on pontoons, and affords a continuous roadway for foot passengers and vehicles. The traffic returns for 41 weeks in 1875 were £7593; the cost of the bridge has been £220,000. The main duty of the Port Commissioners has hitherto consisted in providing accommodation, by jetties and warehouses, for the shipping and native boats, which carry on the great and increasing trade of Calcutta.

In the year 1873–74 the income of the commissioners from all sources was £114,709, and the expenditure £78,260. The total amount of capital expended up to that year was £580,339, including a debt of £400,123. The number of vessels arriving and departing in 1861–62 was 1793, with an aggregate tonnage of 1,337,632 tons; in 1873–74, the number of vessels was 1927, tonnage 2,437,447. The number of steamers, and especially of steamers passing through the Suez Canal, is greatly on the increase.

The growth of the commerce of Calcutta may be seen from the following figures:—In 1820-21 the total value of the exports and imports, including treasure, was £10,454,910; in 1830-31, £8,758,352; in 1840-41, £15,292,697; in 1850-51, £18,754,625; in 1860-61, £31,794,671; in 1870-71, £49,316,782. The value of the customs duties (including salt) was in 1820-21, £151,317; 1830-31, £121,321; 1840-41, £495,515; 1850-51, £1,088,285; 1860-61, £2,270,654; 1870-71, £3,548,628. Cotton goods first became an important article of import in 1824; oil seeds were first exported in 1835; the exports of jute on a large scale date from 1850, those of tea from 1854. Among the chief articles of import in 1870-71 were—apparel, value £136,767; beer, £140,256; coal, £162,135; cotton manufactured, £11,624,712; machinery, £194,192; metals, £1,811,547; railway materials, £710,257; salt, £652,622; spices, £150,166; spirits, £162,635; wine, £214,191; wood, £158,663; woollen manufactures, £247,116; treasure, £2,255,244; Government shipments, £331,557; total value of imports, £21,198,472. Among the chief articles of export in 1870-71 were—cotton raw, £2,020,156; cotton manufactured, £211,625; dyeing materials, £158,118; grain and pulse, £2,630,451; hides and skins, £1,572,655; indigo, £2,225,202; jute, £2,585,220; jute manufactured, £784,222; lac, £194,076; metals, £215,920; opium, £5,450,885; saltpetre, £449,122; seeds, £2,021,117; silk, £1,066,301; silk manufactured, £244,076; spices, £215,612; sugar, £674,142; tea, £1,117,712; tobacco, £152,716; woollen manufactures, £128,652; bullion and treasure, £1,621,633; Government treasure, £225,624; total value of exports, £22,118,310.

The internal trade of Calcutta is conducted partly by railway, and partly by water traffic. There is no railway station within the limits of the municipality, but three separate railways have their terminus in the immediate neighbourhood. The East Indian Railway, whose terminus is across the river at Hówrah, brings down the produce of the North-Western Provinces and Behar, and connects Calcutta with the general railway system of the Peninsula. The Eastern Bengal Railway and the South-Eastern Railway have their terminus at Sïáldah, an eastern suburb of Calcutta. The former is an important line running across the Delta to the junction of the Ganges and Brahmaputra at Goalandá. The latter is a short railway, intended to connect the metropolis with Port Canning, in the Sundarbans. The three chief lines of water traffic are (1), the Calcutta canals, a chain of channels and rivers passing round and through the Sundarbans, open at all seasons of the year, and affording the main line of communication with the Ganges and the Brahmaputra; (2), the Nadiyá rivers, three in number, which branch off in a more directly southern course from the Ganges, above its junction with the Brahmaputra, and ultimately become the Húglí—these are with difficulty navigable during the dry season; (3), the Midnapur and Hijili canals, leading south towards Orissa. (W. W. H.)

CALDANI, Leopold Marco Antonio (1725–1813), a distinguished Italian anatomist and physician, was born at Bologna in 1725. After holding various minor appointments, he was chosen assistant to the celebrated anatomist Morgagni at Padua; but disgusted with the envy which his distinguished position drew upon him, he removed to Venice. Soon after, however, he was appointed to the professorship of the theory of medicine, with the promise of being elected to succeed Morgagni, who was then old and infirm. In 1772 he published his *Elements of Pathology*, and soon afterwards the *Elements of Physiology*. In the same year he took possession of the chair of anatomy, vacant by the death of Morgagni, and endeavoured, though without success, to found an anatomical museum. At the age of seventy-six, though threatened with blindness, he published, with the assistance of his nephew, a valuable series of anatomical plates. He died in 1813, at the age of eighty-eight.

CALDER, Sir Robert (1745–1818), Baronet, was born at Elgin, in Scotland, July 2, 1745 (o. s.) He belonged to a very ancient family of Morayshire, and was the second son of Sir Thomas Calder of Muirton. He was educated at the grammar school of Elgin, and at the age of fourteen entered the British navy as midshipman. In 1766 he was serving as lieutenant of the "*Essex*," under captain the Honourable George Faulkner, in the West Indies. Promotion came slowly, and it was not till 1782 that he attained the rank of post-captain. He acquitted himself honourably in the various services to which he was called, but for a long time had no opportunity of distinguishing himself. In 1796 he was named captain of the fleet by Sir John Jervis, and took part in the great battle off Cape St Vincent (February 14, 1797). He was selected as bearer of the despatches announcing the victory, and on that occasion was knighted by George III. He also received the thanks of parliament, and in the following year was created a baronet. In 1799 he became rear-admiral; and in 1801 he was despatched with a small squadron in pursuit of a French force, under Admiral Gantheaume, conveying supplies to the French in Egypt. In this pursuit he was not successful, and returning home at the peace, he struck his flag. When the war again broke out he was recalled to service, was promoted vice-admiral in 1804, and was employed in the following year in the blockade of the ports of Ferrol and Coruña, in which (amongst other ports) ships were preparing for the invasion of England by Napoleon I. He held his position with a force greatly inferior to that of the enemy, and refused to be enticed out to sea. On its becoming known that the first movement directed by Napoleon was the raising of the blockade of Ferrol, Rear-admiral Stirling was ordered to join Sir R. Calder and cruise with him to intercept the fleets of France and Spain on their passage to Brest. The approach of the enemy was concealed by a fog; but on July 22, 1805, their fleet came in sight. It still outnumbered the British force; but Sir Robert entered into action. After a combat of four hours, during which he captured two Spanish ships, he gave orders to discontinue the action. He offered battle again on the two following days, but the challenge was not accepted. The French admiral, Villeneuve, however, did not pursue his voyage, but took refuge in Ferrol. In the judgment of Napoleon, his scheme of invasion was baffled by this day's action; but much indignation was felt in England at the failure of Calder to win a complete victory. He was, nevertheless, again sent out in August, and prevented Villeneuve from effecting a junction with the French fleet at Brest. In consequence of the strong feeling against him at home he demanded a court-martial. This was held on the 23d of December, and resulted in a severe reprimand of the vice-admiral for not having done his utmost to renew the engagement, at the same time acquitting him both of cowardice and disaffection. False expectations had been raised in England by the mutilation of his despatches, and of this he indignantly complained in his defence. The tide of feeling, however, turned again; and in 1815, by way of public testimony to his services, and of acquittal of the charge made against him, he was appointed commander of Portsmouth. He died at Holt, near Bishop's Waltham, in Hampshire, August 31, 1818.

lonia; but in 1651 he entered the church, and from that period wrote nothing but spectacular plays for representation at court, and the religious pieces known as *Autos Sacramentales.* He received various ecclesiastical preferments from Philip IV., and prolonged his days in wealth and honour until his death on May 25, 1681. Very few traits of his personal character have been preserved, and little else can be extracted from the sonorous eulogium of his friend and biographer Vera Tassis than that he was held in esteem for gravity, urbanity, and modesty. A surer testimony to his character is the spirit of his works, which are animated throughout by a lofty ideal of honour and religion according to the conceptions of his age and country, and are wholly free from the usual impurity of the stage. He must evidently have been a highly accomplished man, possessed of a large stock of erudition.

The entire number of pieces comprised in Hartzenbusch's edition of Calderon, which does not include the *autos sacramentales,* is 122. There are 72 *autos.* It is of course impossible to notice here more than a fraction of this prodigious mass of dramatic poetry. We shall briefly characterize the classes under which it admits of being distributed, adducing a few of the more remarkable dramas as representatives of the whole, and following in the main the admirable arrangement of Schack.

1. *Religious Dramas.*—Of these Schack reckons sixteen, including *The Statue of Prometheus* and *Life is a Dream.* This division comprises some of Calderon's most famous pieces, in particular *The Wonder-working Magician,* in which the brilliancy of his poetical imagination is displayed to the fullest extent, and by Shelley's translation of which he is hitherto best known in England. The subject—the voluntary surrender of a human soul to the Evil One—offers striking analogies and equally strong contrasts to Goethe's *Faust.* The comparison of the two pieces is most instructive, and most forcibly attests the vast progress in depth of thought and complexity of emotion of the modern over the mediæval world. *The Devotion of the Cross* is another of the most remarkable pieces of this class, rich in poetical beauties, and exhibiting Catholic antinomianism in its most unmitigated form. There is a deeper vein of thought in *Life is a Dream,* in which the poet is comparatively free from ecclesiastical influences, and which is also one of his most striking and original productions. *The Constant Prince,* founded on Don Ferdinand of Portugal's captivity, is the very flower of Spanish religion, courtesy, and chivalry, and, like *Life is a Dream,* is an excellent acting play. *The Schism of England* and *The Dayspring in Copacavana,* apart from their great poetical merits, are interesting as indications of the national feeling with regard to nearly contemporary events.

2. Nineteen of Calderon's dramas are classed as historical tragedies. These generally exhibit his talent for effective theatrical situation in the most advantageous light; but in psychological depth and truth he is far behind the great dramatic masters of other countries. The most celebrated of these pieces are founded on incidents in Spanish and Portuguese history, from the posthumous coronation of Iñez de Castro to the heart-rending story of *Gomez Arias's Leman,* and the powerful domestic tragedy of the *Alcalde of Zalamea,* which displays more individuality in the delineation of personal character than is usual with him. Nowhere can a fuller insight be obtained into the peculiarities of the Spanish character and the national ideal while the nation was still a great Catholic and Crusading power. Calderon's treatment of historical fact, it need hardly be said, is frequently as free as Shakspeare's. The most remarkable of his historical plays, whose plots are not derived from the history of his own country, are *No Monster like Jealousy,* a most powerful tragedy on the story of Herod and Mariamne; *The Locks of Absalom,* so greatly admired by Shelley; and *Zenobia the Great.*

3. The subjects of twenty-four of Calderon's pieces are derived from mythology, chivalric romance, or novels. Most of these are merely spectacular, affording little scope for strictly dramatic power, but dazzling from the opulence of the poet's invention, and the sweetness and variety of his versification. He has here given his imagination the freest rein, and is nowhere more truly himself. *No Magic like Love,* a play on the story of Circe; *Echo and Narcissus;* and *The Bridge of Mantible* may be cited as characteristic examples.

4. Sixteen romantic dramas, generally melodramas or tragi-comedies, form the transition from Calderon's tragic to his comic theatre. None of his plays are more distinguished for ingenuity of conception and grace of style. *The Loud Secret* is perhaps the most celebrated, but the rest are of hardly inferior merit.

5. We now come to Calderon's comedies of intrigue, the so-called "comedies of cloak and sword," his delineations of the manners of his day, and of the actual human life around him. His range is an exceedingly limited one in comparison with that of the English dramatists. It hardly transcends the sphere of ordinary good society,—the valets and other representatives of the lower orders being for the most part merely conventional types. The motive of his pieces, moreover, seldom comprehends more than the two prime factors of love and jealousy. Within these limits, however, his perception is commonly correct, and his characters are depicted with more individuality and subtlety than in his more serious pieces. Even his high-flown strain of chivalric sentiment and his punctilious formality correspond to fact. They are artificial indeed, but not affected, for they actually represent the ideal of the best contemporary society, and represent the Spanish cavalier, if not precisely as he was, yet as he wished to be esteemed. The capital merit of these pieces, however, is the prodigious ingenuity of the plots, and the fertility of invention by which our attention is kept continually on the stretch. Calderon's expedients are inexhaustible; every fresh incident surprises, and none appears capricious or unnatural. Twenty-five plays are included under this head. *The Fairy Lady* and *'Tis ill keeping a House with Two Doors* are perhaps the most generally known; all however are nearly upon a level.

6. *Autos Sacramentales.*—A volume might be written upon this most peculiar of all the forms of the modern European drama. We can only describe it here as a development of the mystery or miracle play of the Middle Ages, designed like it for public representation on some specified religious occasion, and falling like it into two classes, the strictly Biblical play, of which Calderon's *Brazen Serpent* is an instance, and the religious allegory. The latter is Calderon's characteristic department, and nothing can surpass the boldness and quaintness of his personifications. Man, the World, Guilt, the Morning Star, the Synagogue, and Apostacy figure, for example, among his innumerable *dramatis personæ.* The riches of his invention and his diction are nowhere more abundant; but the profoundness of his philosophy and theology have been greatly over-estimated by writers of his own religious communion.

7. *Minor Pieces.*—Calderon also composed numerous farces, interludes, and other brief occasional pieces, the greater part of which are lost.

Calderon received the Spanish drama from his predecessors in a flourishing condition, exhausted, in conjunction with his numerous gifted contemporaries, every phase of which it allowed, and left it at his death in a condition of total decay. His retirement from the theatre in middle

life was probably occasioned by the conviction that it admitted of no further development. In his relation to his predecessors he appears as an innovator, chiefly in the simplification of metrical forms. Though at least half of each of his plays is still in complete rhyme, he nevertheless resorts to assonances more liberally than his forerunners. If, on the one hand, this brings him nearer to the language of reality, it on the other sometimes betrays him into verbosity. In his earlier pieces the exuberance of his genius, and the example of the popular lyrical poets of the day, tempted him into conceits and extravagances of diction which are less apparent in his later works. He yet has more fire and colour than any other of the Spanish dramatists, and may be described as the one among them in whom the Oriental element is most largely developed. He shares with his rivals the reproach of repetition, of calculated stage effect, and of stereotyped forms of expression, which become at length mere convention and surplusage. The peculiarity of the form of composition cultivated by Calderon renders it difficult to assign his relative rank among poets of the first class. The Spanish drama is a creation *sui generis*, and all attempts at a comparison between it and other theatrical forms must be futile for want of a common measure. The art of Calderon attains its purpose not less completely than that of Shakespeare or Sophocles; all that can be said in its disparagement is that this purpose is less elevated. It falls below the art of Greece, inasmuch as it makes no pretension to represent the ideal either of divinity or of manhood; and below the art of Shakespeare, inasmuch as, instead of offering a mirror to universal nature, it is restricted to the representation or poetic expression of a temporary and accidental phase of manners. It is the most perfect embodiment conceivable of all the romantic and chivalrous elements of Spanish national life; there is not, perhaps, such another example in literature of the wonderful power of poetry to eliminate all baser matter, and present the innermost idea of a society in untarnished brightness. Calderon is also the most perfect representative of the state of feeling induced by unconditional allegiance to the Catholic Church, at the critical moment when the scales of faith and knowledge are yet in equilibrium. Great Catholic poets may yet arise, with even more than Calderon's depth of conviction, but none can again enjoy Calderon's serenity. There is no disturbing element in his world, either of innovation or of resistance; he is everything which by theory a consummate Catholic poet ought to be. It is therefore but logical that he should be set up as the rival of Shakespeare by the partisans of the mediæval revival, of whom Frederick Schlegel is the most eminent literary representative. It would be a waste of time to contrast the conventional uniformity of his pieces, reducible to five or six types at most, with Shakespeare's infinite variety; the faint individualization of his characters with Shakespeare's miraculous subtlety; his class prejudices with Shakespeare's universal sympathy; his stereotyped cast of thought with Shakespeare's comprehensive wisdom. It is enough to remark, that greatly as he is admired and widely as he is read, he has not contributed a single appreciable element to the literature of any country but his own, while Shakespeare has revolutionized the taste of Europe. His relation to his contemporaries is also different from Shakespeare's. Shakespeare is a sun among stars; Calderon the brightest star of a group. We shall render him most justice, not by instituting a vain parallel with Shakespeare, or even Goethe, but by regarding those qualities which he necessarily has in common with all poetical dramatists. In these respects it is impossible to praise him too highly Nothing can surpass the fertility, ingenuity, and consistency of his constructive faculty on the one hand, or the affluence of his imagery and melody of his versification on the other. The poet and the playwright are happily combined in him; the development of his plots holds the spectator in suspense from first to last, and the diction, except in designedly comic passages, seldom lapses below the pitch of dignified and exquisite poetry. Even the extravagance of his hyperboles appears almost natural amid the general torrent of impassioned feeling. The interminable length of many of his speeches is certainly a fault, and is partly attributable to the fluency and facility of his metre. If we regard him as a tragic poet, we must allow him power, restricted by the absence of any philosophical view of human nature or destiny. As a comic poet he excels in the *vis comica* of situation; but his dialogue is more remarkable for vivacity than humour. His proper and peculiar sphere is that of the fancifully poetical. His inventiveness is here equal to any feat of construction, and his imagination to any opulence of adornment. After Shakespeare and Aristophanes, no dramatist has understood so well how to transport his reader or spectator to an ideal world.

Calderon's metrical forms, although, as already stated, less rich and intricate than those of the earlier Spanish dramatists, are nevertheless a great obstacle to his being adequately translated. No language but the German, in fact, is adapted to render him. Gries's version in that language is very celebrated. Schlegel and Schack have rendered some plays very well; and the *autos* have been translated by Lorinser. Shelley's version of some scenes of the *Wonder-working Magician* is incomparably the best English interpretation, and no reproduction in our language will ever be perfectly successful that does not proceed upon his principle of intermingling blank verse with irregular lyrical metres. Mr Fitzgerald and Mr D. F. M'Carthy, two excellent translators, have erred,—the former by resorting to blank verse entirely, the latter by discarding it altogether. Mr Fitzgerald's version is too English, and Mr M'Carthy's too Spanish; the peculiar delicacy of the assonant rhyme, which he has endeavoured to preserve throughout, is entirely imperceptible in our language. Mr Fitzgerald has rendered six plays, and Mr M'Carthy eleven. There is perhaps no more congenial field for a writer of a poetical temperament than the translation of Calderon.

The chronology of Calderon's pieces is unsettled, but much has been done to adjust it. Many of them were printed during his life, but the first collective edition was that published in 1685 by his friend Vera Tassis. It is not quite complete, and some plays, including most of the author's dramatic trifles, are irremediably lost. The best edition is that by Hartzenbusch in Aribau's *Biblioteca de Autores Españoles* (4 vols., Madrid, 1848–50). It does not contain the *autos*, which were published at Madrid in 1717 and in 1759–60. There is also a good edition by Keil (Hamburg, 1827–30). Accounts of Calderon will be found in Bouterwek, Ticknor, and other historians of Spanish literature; but the best and fullest is that by Schack in his *Geschichte der dramatischen Literatur und Kunst in Spanien*, vol. iii. (Berlin, 1846.) (R. G.)

CALDERWOOD, David (1575–1650), an historian of the Church of Scotland, was born in 1575. He was educated at Edinburgh, where he took the degree of M.A. in 1593. About 1604 he became minister of Crailing, near Jedburgh, and he speedily began to take part in the ecclesiastical proceedings of that period, and was conspicuous for his resolute opposition to the introduction of Episcopacy. In 1617, while James was in Scotland, a Remonstrance which had been drawn up by the Presbyterian clergy was placed in Calderwood's hands. He was summoned to St Andrews and examined before the king, but neither threats nor promises could make him yield, and deliver up the roll of signatures to the Remonstrance. He was deprived of his charge, committed to prison at St Andrews, and afterwards removed to Edinburgh. The privy council, which long exercised an undefined and despotic jurisdiction, ordained him to be banished from the kingdom for refusing to

acknowledge the sentence of the High Commission. On giving security to banish himself from the kingdom before the ensuing Michaelmas, and not to return without the royal licence, he was released from prison. He accompanied Lord Cranstoun to Carlisle, where that nobleman presented a petition in his favour to the king; but it was followed by no beneficial result. The subsequent application of Lord Cranstoun to the privy-council, and to the bishops, was attended with no better success. He lingered in Scotland, publishing a few tracts, till the 27th of August 1619, when he sailed for Holland. Where he chiefly resided in that country we are not informed, but Bishop Guthry states, that "in the time of his exile he had seen the wild follies of the English Brownists in Arnheim and Amsterdam." During his residence in Holland he published various works, and, among the rest, his *Altare Damascenum*. At one period his enemies supposed him to be dead; and he has recorded a very extraordinary attempt to impose upon the world a recantation fabricated in his name. Calderwood appears to have returned to Scotland in 1624, and he was soon afterwards appointed minister of Pencaitland, in the county of Haddington. During the remainder of his life he continued to take an active part in the affairs of the church, and he introduced in 1649 the practice, now confirmed by long usage, of dissenting from the decision of the Assembly, and requiring the protest to be entered in the record. His last years were devoted to the preparation of a *History of the Church of Scotland*. In 1648 the General Assembly urged him to complete the work he had designed, and voted him a yearly pension of £800. He left behind him an historical work of great extent and of great value, not indeed as a masterly composition, but as a storehouse of authentic materials for history. An abridgment, which appears to have been prepared by himself, was published after his death. An excellent edition of the complete work was published by the Wodrow Society, 8 vols. 1842–49. The manuscript, which belonged to General Calderwood Durham, was presented to the British Museum. A copy, transcribed under the inspection of Wodrow, is among the archives of the church; another belongs to the library of the university of Glasgow; and, as Dr M'Crie has stated, "in the Advocates' Library, besides a complete copy of that work, there is a folio volume of it, reaching to the end of the year 1572. It was written in 1634, and has a number of interlineations and marginal alterations, differing from the other copies, which, if not made by the author's own hand, were most probably done under his eye." Calderwood died at Jedburgh on the 29th of October 1650, aged seventy-five. He appears to have been a man of unbending integrity, fearless in maintaining his opinions, and uniformly consistent in his professions; but as human virtues are never perfect, his decision of character had some tendency to deviate into that obstinacy from which good men are not always exempted.

CALEDONIA, used in general somewhat loosely to denote the northern portion of Britain during the period of the Roman occupation of the island, had originally a more restricted application. It is proposed in this article to give, from a geographical as well as an historical point of view, a brief account of what seems to have been known regarding it in ancient times.

The word *Caledonia* is first met with in the fourth book of Pliny's *Historia Naturalis* (*circa* 77 A.D.), where, in the very meagre notice of Britain, the Caledonian forest (*Caledonia sylva*) is given as the northern boundary of the Roman part of the island. Its next appearance is in the *Agricola* of Tacitus (96 A.D.) Here, both in the brief geographical description of Britain, chaps. x. and xi., and in the account of Agricola's campaigns, chaps. xxv.–xxxviii., Caledonia is unquestionably Britain north of the Firth of Forth. On turning to the geographer Ptolemy (*circa* 120 A.D.), we fail to meet with the term except as the name of one of the many tribes among which he has parcelled out the "Bretannic Island, Albion." To explain this it is not necessary to assume that Ptolemy was ignorant of the wider acceptation in which Caledonia had recently come to be employed among the Romans. It is more reasonable to suppose that, as he avowedly drew the materials for his tables from earlier, chiefly from Tyrian sources, he judged it prudent to follow in the main long-recognized authorities. Yet even in Ptolemy we have an indication either of the importance of the Caledonians among their neighbours or of the occasional use of the word as a general name for all the northern tribes. Twice he gives the Deucaledonian Ocean as bounding Britain on the north, that is, after the necessary correction for his mistake in making the whole of the northern part of the island trend to the east instead of to the north, as washing the shores of modern Scotland on the west. Confused and inaccurate in some respects as the Alexandrian geographer's tables are, they, notwithstanding, contain a surprising amount of information regarding the leading features of the coast-line of Britain, the correctness of much of which can be verified by existing names. His account of the tribes and their towns, especially towards the north, is, as might have been expected, much less definite and trustworthy. In order to be able to give here some notice of the Ptolemaic geography of North Britain, Caledonia may for the moment be regarded as a synonymous term.

Ptolemy's error in turning the northern part of the island to the east has already been noticed. How he was led into it there are no means of determining. One effect of it is to exaggerate greatly the length of the Solway Firth and displace the Hebrides from their true position, as may be seen by referring to certain maps appended to several MSS. of the Geography and given with some editions of it. The error can easily be rectified; and when this is done the outline of the coast will be found to be wonderfully correct.[1] Commencing with the promontory of the Noouantai (Mull of Galloway) in the south-west and proceeding northwards along the shores of the Deucaledonian Ocean, we have in succession the Bay of Rerigonios (Loch Ryan), the Bay of Ouindogara (Ayr), the estuary of the Klota (Clyde), the Bay of Lelaamnonios (Loch Fyne), Cape Epidion (Mull of Kintyre), the outlets of the River Longus (Loch Linnhe ?), outlets of the River Ituos, Bay of O.olsas (Lochalsh?), outlets of the River Nabaios, and Cape Tarouedoum or Orkas (Dunnet Head). Coming down the east coast, said to be washed by the German Ocean, we find Cape Ouirouedroum (Duncansbay Head), Cape Oueroubium (Noss Head ?), the outlets of the River Ila, the High Bank, outlets of the River Loxa, estuary of the Ouarar (Moray Firth), estuary of the Touaisis (Spey ?), outlets of the River Kelnios (Deveron ?), the promontory of the Taizalai (Kinnaird's Head), outlets of the River Deoua (Dee), estuary of the Taoua (Tay), outlets of the River Tina, estuary of the Boderia (Firth of Forth), outlets of the River Alaunos, outlets of the River Ouedra (Tyne ?). On the south, bounded by the Hibernian Ocean, we have the peninsula of the Noouantai (the Rhinns of Galloway), outlets of the River Abraouannos (Luce ?), estuary of the Iena (Cree ?), estuary of the Deoua (Dee), outlets of the River Noouios (Nith), outlets of the Itouna (Eden).

The country is represented as inhabited by the following

[1] The orthography of the names that follow is that of the text of Ptolemy (Wilberg's), and not of the Latin translation. With a few exceptions they are evidently intended to express native terms by means of Greek (perhaps originally Tyrian) characters, and it seems undesirable to obscure them further by presenting them in those of another language

tribes, sixteen in number:—the Noouantai, dwelling under (*i.e.*, east) of the peninsula of the same name (Wigtonshire), their towns Loukopibia and Retigonion; east of them the Selgoouai (along the Solway Firth, and inland), their towns Karbantorigon, Ouxellon (Dumfries?), Korda, Trimontion; still further east, the Otadinoi, probably along the south-east coast, their towns Kouria and Bremenion; and the Damnonioi, occupying apparently the basins of the Clyde, Forth, and Tay (in part), their towns Kolania, Ouandouara (Ayr?), Koria, Alauna (Stirling?), Lindon, Ouiktoria (near Perth); the Kaledonioi, in the district from Loch Fyne to the Moray Firth, with the Caledonian forest to the west of them; eastward the Ouakomagoi (Banff and parts of Moray and Aberdeen), their towns Banatia, Tameia, the Winged Camp, Touaisis; east of these the Taizaloi (part of Aberdeenshire), their town Deouana (Aberdeen), and the Ouenicones (Forfarshire), their town Orrea (Forfar?); while occupying the west of Argyll and Inverness, part of Ross-shire, and the whole of Sutherland and Caithness, were in succession the Epidioi (in Kintyre), Kerones, Kreones, Karnonakai, Karinoi, Kornauioi (Caithness), Decantai, Lougoi, and Smertai. Near the promontory of Orkas were the islands of Okitis and Doumna; north of which lay the Orkades (Orkneys), about thirty in number, and still farther north Thoule (Shetland?).

Ptolemy's description is the only detailed one we have till we come down to the 16th century. It is matter for regret that the *Antonine Itinerary*, so useful an aid to the identification of the Ptolemaic towns in the southern part of the island, does not extend to the north, and that the lists of the anonymous geographer of Ravenna are so corrupt as to be almost useless. About the middle of the last century a new element of confusion was introduced into what was tangled enough previously, by the publication of Bertram's well-known forgery *De Situ Britanniæ*, falsely ascribed to Richard of Cirencester, which being accepted as genuine by Roy, Chalmers, Stuart, and others, has been the means of giving currency to many unfounded notions regarding the nature and extent of the Roman conquests in North Britain.

The written history of Caledonia as well as of the rest of what is now Scotland commences with the warlike operations in Britain of Agricola, the lieutenant of the Emperor Domitian. (See BRITANNIA, p. 353.) In the third year of his command this famous general, who was fortunate enough to have his son-in-law Tacitus as his biographer, determined to attempt the annexation of the northern portion of the island. Accordingly, in 80 A.D., he advanced as far as the estuary of the Taus, or as Wex reads, the Tanaus. Whatever the true reading may be, the supposition that on this occasion Agricola reached the Tay is untenable; though, whether the river referred to be the English Tyne, the Tweed, or the Scotch Tyne, it is impossible to say. The succeeding summer found him as far north as the isthmus formed by the firths of Clota and Bodotria (Clyde and Forth). On it he erected a line of forts, with the intention apparently of making it the northern boundary of the empire in those parts. In the following year he crossed the Clota, and overran additional territory "in that part of Britain which looks towards Ireland." Information having now reached him that the remoter and still unconquered tribes were forming a combination against the Romans, he resolved to anticipate them, and (83 A.D.) carried the war beyond the Bodotria into the country of the Caledonians. That summer an engagement was fought, which, though it resulted in favour of the invaders, taught the Romans that they had no ordinary foe to cope with. On the approach of winter both sides retired to their quarters to make preparations for renewing the struggle. Next season (84) Agricola, on resuming the offensive, found himself confronted by a grand union of all the tribes of Caledonia, under a leader whom Tacitus names Galgacus. The Roman general had previously despatched a fleet to ravage the coast, and on continuing his march northwards, encountered the enemy, upwards of 30,000 strong, near Mount Graupius; for there can be little doubt that this, the reading of Wex and Kritz, ought to be adopted instead of the Grampius of the common editions. The exact locality of the conflict that ensued has been the theme of much profitless controversy; but we shall probably not greatly err in placing it somewhere on the borders of Kincardineshire. General Roy, whose conjecture is usually followed, fixed on Ardoch in Perthshire. A careful study, however, of the whole narrative leads one to look for the field of battle farther north, and nearer the coast. Tacitus, writing on the model of Thucydides and Livy, has put into the mouth of each leader, on the eve of the engagement, a speech of his own composition, in which he describes the feelings that may be supposed to have actuated the hostile armies. That ascribed to Galgacus is a splendid specimen of polished sarcasm, mixed with impassioned appeals to the patriotism of his hearers. Might, however, prevailed over right, and the Caledonians were defeated with a loss of 10,000 men. Agricola, now thinking he had pushed his conquests far enough, made no attempt to pursue his beaten foe, but at once led his army back to the territory of the Boresti (*al.* Horesti), whose name is probably preserved in the modern Forfar. Here he gave orders to the commander of his fleet to sail round the island, a feat which the latter accomplished. Soon after he himself was recalled to Rome by his jealous master.

Notwithstanding Agricola's success, the Romans seem to have been quickly obliged to abandon part of their conquests, for in less than forty years (129 A.D.) Hadrian's wall, which ran from the Tyne to the Solway, became the northern limits of their empire in Britain. About twenty years later a second Agricola appeared in the person of Lollius Urbicus, the lieutenant of Antoninus Pius. Almost nothing is known of his actions, but he seems to have once more carried the arms of Rome to the Clyde and Forth, if not beyond them, and to have erected on the line of Agricola's forts the more substantial work now known by the name of the emperor he served (see ANTONINUS, WALL OF). The natives must soon have recovered the lost ground; but scarcely anything is known henceforth of the state of affairs in the north till 208, when, if we may trust the historian Dion Cassius, as abridged by Xiphiline, the Emperor Severus determined to attempt the subjugation of the whole island. At that time the two most powerful tribes of North Britain were the Mæatæ, close to Hadrian's Wall, and the Caledonians beyond them. Protected by their native fastnesses, the latter offered him such a resistance that, without being able to bring them to a decisive engagement, he lost through disease, fatigue, and the sword, no fewer, it is said, than 50,000 men. Having reached what is termed the northern extremity of the island, but which was in all likelihood merely the northern coast of Aberdeenshire, Severus retreated southwards in a very feeble state of health, partly induced by the fatigues he had undergone. A league formed the next year between the Caledonians and the Mæatæ, both of whom had already cast off his authority, led him to make preparations for a new campaign, with the avowed determination of extirpating the whole race. In the midst of these, however, he died at York in 210.

For a whole century afterwards the ancient writers are almost silent regarding Caledonia. In the year 310 we hear for the first time of the Picts; and in 367 Theodosius, an able Roman general, was sent into Britain by Valentinian I. to defend the Britons of the south against the

attacks of the men of the north, represented by Ammianus Marcellinus as being the Picts divided into two tribes (the Dicaledones and the Vecturiones), the Saxons, the Attacotti, and the Scots. He was so far successful that the countries between the walls of Hadrian and Antoninus became yet again a subjected province, named Valentian by Theodosius, in honour of the emperor,—a conquest, however, which can have lasted but a brief period. Henceforth, if we except the effusions of the poet Claudian, the scanty notices of Britain to be met with during several succeeding centuries present the same sad tale of sufferings inflicted on the now effeminate Britons of the south by their warlike neighbours, till at length the settlement of large bodies of Saxons in England changed the aspect of affairs.

The etymology of the word Caledonia has been variously given. *Celydd* (in Welsh, a woody shelter) is the popular derivation; but Isaac Taylor (*Words and Places*, p. 44) thinks the word may possibly contain the root *gael*, and if so, the Caledonians would be the Gaels of the duns or hills. Equally obscure are the ethnological relations of the people, the most probable opinion being that which regards them as belonging to the British branch of the great Celtic family. A casual inference, hazarded by Tacitus (*Agricola*, chap. xi.), that the red hair and large limbs of the inhabitants of Caledonia point clearly to a German origin, must not be pressed too far. There were probably even in his day Teutonic settlements along our eastern and northern shores, but it seems too much to assume that that race was the dominant one north of the Forth. It is a still more doubtful question to what race the Picts belonged. But the discussion of these and other points belongs to the history of SCOTLAND (*q.v.*) (See *Claudii Ptolemæi Geographia*, ed. Wilberg, Essendiæ, 1838; Roy's *Military Antiquities of the Romans in North Britain*, London, 1793; Burton's *History of Scotland*, vol. i., Edin. 1867.) (J. M'D.)

CALENBERG, or KALENBERG, a former principality of Hanover, which was traversed by the Weser and the Leine, and had an area of about 1050 square miles. It derived its name from an ancient castle, now in ruins. In the Middle Ages it belonged to Lüneburg, and after passing from one branch to another of the house of Brunswick, it came, in 1705, to Ernst August, electoral prince of Hanover.

CALENDAR

A CALENDAR is a method of distributing time into certain periods adapted to the purposes of civil life, as hours, days, weeks, months, years, &c.

Of all the periods marked out by the motions of the celestial bodies, the most conspicuous, and the most intimately connected with the affairs of mankind, are the *solar day*, which is distinguished by the diurnal revolution of the earth and the alternation of light and darkness, and the *solar year*, which completes the circle of the seasons. But in the early ages of the world, when mankind were chiefly engaged in rural occupations, the phases of the moon must have been objects of great attention and interest,—hence the *month*, and the practice adopted by many nations of reckoning time by the motions of the moon, as well as the still more general practice of combining lunar with solar periods. The solar day, the solar year, and the lunar month, or lunation, may therefore be called the *natural* divisions of time. All others, as the hour, the week, and the civil month, though of the most ancient and general use, are only arbitrary and conventional.

DAY.—The true solar day is the interval of time which elapses between two consecutive returns of the same terrestrial meridian to the sun. By reason of the inclined position of the ecliptic, and the unequal progressive motion of the earth in its orbit, it is not always of the same absolute length. But as it would be hardly possible, in the artificial measurement of time, to have regard to this small inequality which is besides constantly varying, the *mean solar day* is employed for all civil purposes. This is the time in which the earth *would* make one revolution on its axis, as compared with the sun, if the earth moved at an equable rate in the plane of the equator. The mean solar day is therefore a result of computation, and is not marked precisely by any astronomical phenomenon; but its difference from the true solar or apparent day is so small as to escape ordinary observation.

The subdivision of the day into twenty-four parts, or hours, has prevailed since the remotest ages, though different nations have not agreed either with respect to the epoch of its commencement or the manner of distributing the hours. Europeans in general, like the ancient Egyptians, place the commencement of the civil day at midnight, and reckon twelve morning hours from midnight to mid day, and twelve evening hours from mid-day to midnight. Astronomers, after the example of Ptolemy, regard the day as commencing with the sun's culmination, or noon, and find it most convenient for the purposes of computation to reckon through the whole twenty-four hours. Hipparchus reckoned the twenty-four hours from midnight to midnight. Some nations, as the ancient Chaldeans and the modern Greeks, have chosen sunrise for the commencement of the day; others, again, as the Italians and Bohemians, suppose it to commence at sunset. In all these cases the beginning of the day varies with the seasons at all places not under the equator. In the early ages of Rome, and even down to the middle of the 5th century after the foundation of the city, no other divisions of the day were known than sunrise, sunset, and mid-day, which was marked by the arrival of the sun between the Rostra and a place called Græcostasis, where ambassadors from Greece and other countries used to stand. The Greeks divided the natural day and night into twelve equal parts each, and the hours thus formed were denominated *temporary hours*, from their varying in length according to the seasons of the year. The hours of the day and night were of course only equal at the time of the equinoxes. The whole period of day and night they called νυχθήμερον.

WEEK.—The week is a period of seven days, having no reference whatever to the celestial motions,—a circumstance to which it owes its unalterable uniformity. Although it did not enter into the calendar of the Greeks, and was not introduced at Rome till after the reign of Theodosius, it has been employed from time immemorial in almost all eastern countries; and as it forms neither an aliquot part of the year nor of the lunar month, those who reject the Mosaic recital will be at a loss, as Delambre remarks, to assign to it an origin having much semblance of probability. It might have been suggested by the phases of the moon, or by the number of the planets known in ancient times, an origin which is rendered more probable from the names universally given to the different days of which it is composed. In the Egyptian astronomy, the order of the planets, beginning with the most remote, is Saturn, Jupiter, Mars, the Sun, Venus, Mercury, the Moon. Now, the day being divided into twenty-four hours, each hour was consecrated to a particular planet, namely, one to Saturn, the following to Jupiter, the third to Mars, and so on according to the above order; and the day received the name

planet which presided over its first hour. If, then, the first hour of a day was consecrated to Saturn, that planet would also have the 8th, the 15th, and the 22nd hour; the 23rd would fall to Jupiter, the 24th to Mars, and the 25th, or the first hour of the second day, would belong to the Sun. In like manner the first hour of the 3rd day would fall to the Moon, the first of the 4th day to Mars, of the 5th to Mercury, of the 6th to Jupiter, and of the 7th to Venus. The cycle being completed, the first hour of the 8th day would return to Saturn, and all the others succeed in the same order. According to Dio Cassius, the Egyptian week commenced with Saturday. On their flight from Egypt, the Jews, from hatred to their ancient oppressors, made Saturday the last day of the week.

The English names of the days are derived from the Saxon. The ancient Saxons had borrowed the week from some Eastern nation, and substituted the names of their own divinities for those of the gods of Greece. In legislative and justiciary acts the Latin names are still retained.

Latin.	English.	Saxon
Dies Solis.	Sunday.	Sun's day.
Dies Lunæ.	Monday.	Moon's day.
Dies Martis.	Tuesday.	Tiw's day.
Dies Mercurii.	Wednesday.	Woden's day.
Dies Jovis.	Thursday.	Thor's day.
Dies Veneris	Friday.	Friga's day.
Dies Saturni.	Saturday.	Seterne's day.

MONTH.—Long before the exact length of the year was determined, it must have been perceived that the synodic revolution of the moon is accomplished in about 29½ days. Twelve lunations, therefore, form a period of 354 days, which differs only by about 11¼ days from the solar year. From this circumstance has arisen the practice, perhaps universal, of dividing the year into twelve *months*. But in the course of a few years the accumulated difference between the solar year and twelve lunar months would become considerable, and have the effect of transporting the commencement of the year to a different season. The difficulties that arose in attempting to avoid this inconvenience induced some nations to abandon the moon altogether, and regulate their year by the course of the sun. The month, however, being a convenient period of time, has retained its place in the calendars of all nations; but, instead of denoting a synodic revolution of the moon, it is usually employed to denote an arbitrary number of days approaching to the twelfth part of a solar year.

Among the ancient Egyptians the month consisted of thirty days invariably; and in order to complete the year, five days were added at the end, called supplementary days. They made use of no intercalation, and by losing a fourth of a day every year, the commencement of the year went back one day in every period of four years, and consequently made a revolution of the seasons in 1461 years. Hence 1461 Egyptian years are equal to 1460 Julian years of 365¼ days each. This year is called *vague*, by reason of its commencing sometimes at one season of the year, and sometimes at another.

The Greeks divided the month into three decades, or periods of ten days,—a practice which was imitated by the French in their unsuccessful attempt to introduce a new calendar at the period of the Revolution. This division offers two advantages: the first is, that the period is an exact measure of the month of thirty days; and the second is, that the number of the day of the decade is connected with and suggests the number of the day of the month. For example, the 5th of the decade must necessarily be the 5th, the 15th, or the 25th of the month; so that when the day of the decade is known, that of the month can scarcely be mistaken. In reckoning by weeks, it is necessary to keep in mind the day of the week on which each month begins.

The Romans employed a division of the month and a method of reckoning the days which appear not a little extraordinary, and must, in practice, have been exceedingly inconvenient. As frequent allusion is made by classical writers to this embarrassing method of computation, which is carefully retained in the ecclesiastical calendar, we here give a table showing the correspondence of the Roman months with those of modern Europe.

Days of the Month.	March. May. July. October.	January. August. December.	April. June. September. November.	February.
1	Calendæ.	Calendæ.	Calendæ.	Calendæ.
2	6	4	4	4
3	5	3	3	3
4	4	Prid. Nonas.	Prid. Nonas.	Prid. Nonas.
5	3	Nonæ.	Nonæ.	Nonæ.
6	Prid. Nonas.	8	8	8
7	Nonæ.	7	7	7
8	8	6	6	6
9	7	5	5	5
10	6	4	4	4
11	5	3	3	3
12	4	Prid. Idus.	Prid. Idus.	Prid. Idus.
13	3	Idus.	Idus.	Idus.
14	Prid. Idus.	19	18	16
15	Idus.	18	17	15
16	17	17	16	14
17	16	16	15	13
18	15	15	14	12
19	14	14	13	11
20	13	13	12	10
21	12	12	11	9
22	11	11	10	8
23	10	10	9	7
24	9	9	8	6
25	8	8	7	5
26	7	7	6	4
27	6	6	5	3
28	5	5	4	Prid. Cal. Mart.
29	4	4	3	
30	3	3	Prid. Calen.	
31	Prid. Calen.	Prid. Calen.		

Instead of distinguishing the days by the ordinal numbers first, second, third, &c., the Romans counted *backwards* from three fixed epochs, namely, the *Calends*, the *Nones*, and the *Ides*. The Calends (or Kalends) were invariably the first day of the month, and were so denominated because it had been an ancient custom of the pontiffs to call the people together on that day, to apprize them of the festivals, or days that were to be kept sacred during the month. The Ides (from an obsolete verb *iduare*, to divide) were at the middle of the month, either the 13th or the 15th day; and the Nones were the *ninth* day before the Ides, counting inclusively. From these three terms the days received their denomination in the following manner:—Those which were comprised between the Calends and the Nones were called *the days before the Nones;* those between the Nones and the Ides were called *the days before the Ides;* and, lastly, all the days after the Ides to the end of the month were called *the days before the Calends* of the succeeding month. In the months of March, May, July, and October, the Ides fell on the 15th day, and the Nones consequently on the 7th; so that each of these months had six days named from the Nones. In all the other months the Ides were on the 13th and the Nones on the 5th; consequently there were only four days named from the Nones. Every month had eight days named from the Ides. The number of days receiving their denomination from the Calends depended on the number of days in the month and the day on which the Ides fell. For example, if the month contained 31 days, and the Ides fell on the 13th, as was the case in January, August, and December, there would remain 18 days after the Ides, which, added

to the first of the following month, made 19 days of Calends. In January, therefore, the 14th day of the month was called the *nineteenth before the Calends of February* (counting inclusively), the 15th was the 18th before the Calends, and so on to the 30th, which was called the third before the Calends (*tertio Calendas*), the last being the second of the Calends, or the day before the Calends (*pridie Calendas*).

YEAR.—The year is either astronomical or civil. The solar astronomical year is the period of time in which the earth performs a revolution in its orbit about the sun, or passes from any point of the ecliptic to the same point again; and consists of 365 days 5 hours 48 min. and 46 sec. of mean solar time. The civil year is that which is employed in chronology, and varies among different nations, both in respect of the season at which it commences and of its subdivisions. When regard is had to the sun's motion alone, the regulation of the year, and the distribution of the days into months, may be effected without much trouble; but the difficulty is greatly increased when it is sought to reconcile solar and lunar periods, or to make the subdivisions of the year depend on the moon, and at the same time to preserve the correspondence between the whole year and the seasons.

Of the Solar Year.—In the arrangement of the civil year, two objects are sought to be accomplished,—first, the equable distribution of the days among twelve months; and secondly, the preservation of the beginning of the year at the same distance from the solstices or equinoxes. Now, as the year consists of 365 days and a fraction, and 365 is a number not divisible by 12, it is impossible that the months can all be of the same length, and at the same time include all the days of the year. By reason also of the fractional excess of the length of the year above 365 days, it likewise happens that the years cannot all contain the same number of days if the epoch of their commencement remains fixed; for the day and the civil year must necessarily be considered as beginning at the same instant; and therefore the extra hours cannot be included in the year till they have accumulated to a whole day. As soon as this has taken place, an additional day must be given to the year.

The civil calendar of all European countries has been borrowed from that of the Romans. Romulus is said to have divided the year into ten months only, including in all 304 days, and it is not very well known how the remaining days were disposed of. The ancient Roman year commenced with March, as is indicated by the names September, October, November, December, which the last four months still retain. July and August, likewise, were anciently denominated Quintilis and Sextilis, their present appellations having been bestowed in compliment to Julius Cæsar and Augustus In the reign of Numa two months were added to the year, January at the beginning, and February at the end; and this arrangement continued till the year 452 B.C., when the Decemvirs changed the order of the months, and placed February after January. The months now consisted of twenty-nine and thirty days alternately, to correspond with the synodic revolution of the moon, so that the year contained 354 days; but a day was added to make the number odd, which was considered more fortunate, and the year therefore consisted of 355 days. This differed from the solar year by ten whole days and a fraction; but, to restore the coincidence, Numa ordered an additional or intercalary month to be inserted every second year between the 23rd and 24th of February, consisting of twenty-two and twenty-three days alternately, so that four years contained 1465 days, and the mean length of the year was consequently 366¼ days. The additional month was called *Mercedinus* or *Mercedonius*, from *merces*, wages, probably because the wages of workmen and domestics were usually paid at this season of the year. According to the above arrangement, the year was too long by one day, which rendered another correction necessary. As the error amounted to twenty-four days in as many years, it was ordered that every third period of eight years, instead of containing four intercalary months, amounting in all to ninety days, should contain only three of those months, consisting of twenty-two days each. The mean length of the year was thus reduced to 365¼ days; but it is not certain at what time the octennial periods, borrowed from the Greeks, were introduced into the Roman calendar, or whether they were at any time strictly followed. It does not even appear that the length of the intercalary month was regulated by any certain principle, for a discretionary power was left with the pontiffs, to whom the care of the calendar was committed, to intercalate more or fewer days according as the year was found to differ more or less from the celestial motions. This power was quickly abused to serve political objects, and the calendar consequently thrown into confusion. By giving a greater or less number of days to the intercalary month, the pontiffs were enabled to prolong the term of a magistracy, or hasten the annual elections; and so little care had been taken to regulate the year, that, at the time of Julius Cæsar, the civil equinox differed from the astronomical by three months, so that the winter months were carried back into autumn, and the autumnal into summer.

In order to put an end to the disorders arising from the negligence or ignorance of the pontiffs, Cæsar abolished the use of the lunar year and the intercalary month, and regulated the civil year entirely by the sun. With the advice and assistance of Sosigenes, he fixed the mean length of the year at 365¼ days, and decreed that every fourth year should have 366 days, the other years having each 365. In order to restore the vernal equinox to the 25th of March, the place it occupied in the time of Numa, he ordered two extraordinary months to be inserted between November and December in the current year, the first to consist of thirty-three, and the second of thirty-four days. The intercalary month of twenty-three days fell into the year of course, so that the ancient year of 355 days received an augmentation of ninety days; and the year on that occasion contained in all 445 days. This was called the last year of confusion. The first Julian year commenced with the 1st of January of the 46th before the birth of Christ, and the 708th from the foundation of the city.

In the distribution of the days through the several months, Cæsar adopted a simpler and more commodious arrangement than that which has since prevailed. He had ordered that the first, third, fifth, seventh, ninth, and eleventh months, that is January, March, May, July, September, and November, should have each thirty-one days, and the other months thirty, excepting February, which in common years should have only twenty-nine, but every fourth year thirty days. This order was interrupted to gratify the vanity of Augustus, by giving the month bearing his name as many days as July, which was named after the first Cæsar. A day was accordingly taken from February and given to August; and in order that three months of thirty-one days might not come together, September and November were reduced to thirty days, and thirty-one given to October and December. For so frivolous a reason was the regulation of Cæsar abandoned, and a capricious arrangement introduced, which it requires some attention to remember.

The additional day which occurred every fourth year ... the shortest month, and

was inserted in the calendar between the 24th and 25th day. February having then twenty-nine days, the 25th was the 6th of the calends of March, *sexto calendas;* the preceding, which was the additional or intercalary day, was called *bis-sexto calendas*,—hence the term *bissextile*, which is still employed to distinguish the year of 366 days. The English denomination of *leap-year* would have been more appropriate if that year had differed from common years in *defect*, and contained only 364 days. In the modern calendar the intercalary day is still added to February, not, however, between the 24th and 25th, but as the 29th.

The regulations of Cæsar were not at first sufficiently understood; and the pontiffs, by intercalating every third year instead of every fourth, at the end of thirty-six years had intercalated twelve times, instead of nine. This mistake having been discovered, Augustus ordered that all the years from the thirty-seventh of the era to the forty-eighth inclusive should be common years, by which means the intercalations were reduced to the proper number of twelve in forty-eight years. No account is taken of this blunder in chronology; and it is tacitly supposed that the calendar has been correctly followed from its commencement.

Although the Julian method of intercalation is perhaps the most convenient that could be adopted, yet, as it supposes the year too long by 11 minutes 14 seconds, it could not without correction very long answer the purpose for which it was devised, namely, that of preserving always the same interval of time between the commencement of the year and the equinox. Sosigenes could scarcely fail to know that this year was too long; for it had been shown long before, by the observations of Hipparchus, that the excess of 365¼ days above a true solar year would amount to a day in 300 years. The real error is indeed more than double of this, and amounts to a day in 128 years; but in the time of Cæsar the length of the year was an astronomical element not very well determined. In the course of a few centuries, however, the equinox sensibly retrograded towards the beginning of the year. When the Julian calendar was introduced, the equinox fell on the 25th of March. At the time of the Council of Nice, which was held in 325, it fell on the 21st; and when the reformation of the calendar was made in 1582, it had retrograded to the 11th. In order to restore the equinox to its former place, Pope Gregory XIII. directed ten days to be suppressed in the calendar; and as the error of the Julian intercalation was now found to amount to three days in 400 years, he ordered the intercalations to be omitted on all the centenary years excepting those which are multiples of 400. According to the Gregorian rule of intercalation, therefore, every year of which the number is divisible by four without a remainder, is a leap year, excepting the centurial years, which are only leap years when divisible by four after omitting the two ciphers. Thus 1600 was a leap year, but 1700, 1800, and 1900 are common years; 2000 will be a leap year, and so on.

As the Gregorian method of intercalation has been adopted in all Christian countries, Russia excepted, it becomes interesting to examine with what degree of accuracy it reconciles the civil with the solar year. According to the best determinations of modern astronomy (Le Verrier's *Solar Tables*, Paris, 1858, p. 102), the mean geocentric motion of the sun in longitude, from the mean equinox during a Julian year of 365·25 days, the same being brought up to the present date, is $360° + 27''\cdot685$. Thus the mean length of the solar year is found to be $\frac{360°}{360° + 27''\cdot685} \times 365\cdot25 = 365\cdot2422$ days, or 365 days 5 hours 48 min. 46 sec. Now the Gregorian rule gives 97 intercalations in 400 years; 400 years therefore contain $365 \times 400 + 97$, that is, 146,097 days; and consequently one year contains 365·2425 days, or 365 days 5 hours 49 min. 12 sec. This exceeds the true solar year by 26 seconds, which amount to a day in 3323 years. It is perhaps unnecessary to make any formal provision against an error which can only happen after so long a period of time; but as 3323 differs little from 4000, it has been proposed to correct the Gregorian rule by making the year 4000 and all its multiples common years. With this correction the rule of intercalation is as follows:—

Every year the number of which is divisible by 4 is a leap year, excepting the last year of each century, which is a leap year only when the number of the century is divisible by 4; but 4000, and its multiples, 8000, 12,000, 16,000, &c. are common years. Thus the uniformity of the intercalation, by continuing to depend on the number four, is preserved, and by adopting the last correction the commencement of the year would not vary more than a day from its present place in two hundred centuries.

In order to discover whether the coincidence of the civil and solar year could not be restored in shorter periods by a different method of intercalation, we may proceed as follows:—The fraction 0·2422, which expresses the excess of the solar year above a whole number of days, being converted into a continued fraction, becomes

$$\cfrac{1}{4+\cfrac{1}{7+\cfrac{1}{1+\cfrac{1}{3+\cfrac{1}{4+\cfrac{1}{1+\text{, \&c.}}}}}}}$$

which gives the series of approximating fractions,

$$\frac{1}{4}, \frac{7}{29}, \frac{8}{33}, \frac{31}{128}, \frac{132}{545}, \frac{163}{673}, \text{ \&c.}$$

The first of these, $\frac{1}{4}$, gives the Julian intercalation of one day in four years, and is considerably too great. It supposes the year to contain 365 days 6 hours.

The second, $\frac{7}{29}$, gives seven intercalary days in twenty-nine years, and errs in defect, as it supposes a year of 365 days 5 hours 47 min. 35 sec.

The third, $\frac{8}{33}$, gives eight intercalations in thirty-three years, or seven successive intercalations at the end of four years respectively, and the eighth at the end of five years. This supposes the year to contain 365 days 5 hours 49 min. 5·45 sec.

The fourth fraction, $\frac{31}{128} = \frac{24+7}{99+29} = \frac{3 \times 8 + 7}{3 \times 33 + 29}$, combines three periods of thirty-three years with one of twenty-nine, and would consequently be very convenient in application. It supposes the year to consist of 365 days 5 hours 48 min. 45 sec., and is practically exact.

The fraction $\frac{8}{33}$ offers a convenient and very accurate method of intercalation. It implies a year differing in excess from the true year only by 19·45 seconds, while the Gregorian year is too long by 26 seconds. It produces a much nearer coincidence between the civil and solar years than the Gregorian method; and, by reason of its shortness of period, confines the evagations of the mean equinox from the true within much narrower limits. It has been stated by Scaliger, Weidler, Montucla, and others, that the modern Persians actually follow this method, and intercalate eight days in thirty-three years. The statement has, however, been contested on good authority; and it seems proved (see Delambre, *Astronomie Moderne*, tom. i. p.81) that the Persian intercalation combines the two periods $\frac{7}{29}$ and $\frac{8}{33}$. If they follow the combination $\frac{7+3\times8}{29+3\times33} = \frac{31}{128}$, their determination of the length of the tropical year has been extremely exact. The discovery of the period of thirty-three years is ascribed to Omar Cheyam, one of the eight astronomers appointed by Gelal-Eddin Malech Shah, sultan of Khorassan, to reform or construct a calendar, about the year 1079 of our era.

If the commencement of the year, instead of being retained at the same place in the seasons by a uniform method of intercalation, were made to depend on astronomical phenomena, the intercalations would succeed each other in an irregular manner, sometimes after four years and sometimes after five; and it would occasionally, though rarely indeed, happen, that it would be impossible to determine the day on which the year ought to begin. In the calendar, for example, which was attempted to be introduced in France in 1793, the beginning of the year was fixed at the midnight preceding the day in which the true autumnal equinox falls. But supposing the instant of the sun's entering into the sign *Libra* to be very near midnight, the small errors of the solar tables might render it doubtful to which day the equinox really belonged; and it would be in vain to have recourse to observation to obviate the difficulty. It is therefore infinitely more commodious to determine the commence-

ment of the year by a fixed rule of intercalation; and of the various methods which might be employed, no one, perhaps is on the whole more easy of application, or better adapted for the purpose of computation, than the Gregorian now in use. But a system of 31 intercalations in 128 years would be by far the most perfect as regards mathematical accuracy. Its adoption upon our present Gregorian calendar would only require the suppression of the usual bissextile once in every 128 years, and there would be no necessity for any further correction, as the error is so insignificant that it would not amount to a day in 100,000 years.

Of the Lunar Year and Luni-solar Periods. The lunar year, consisting of twelve lunar months, contains only 354 days; its commencement consequently anticipates that of the solar year by eleven days, and passes through the whole circle of the seasons in about thirty-four lunar years. It is therefore so obviously ill-adapted to the computation of time, that, excepting the modern Jews and Mahometans, almost all nations who have regulated their months by the moon have employed some method of intercalation by means of which the beginning of the year is retained at nearly the same fixed place in the seasons.

In the early ages of Greece the year was regulated entirely by the moon. Solon divided the year into twelve months, consisting alternately of twenty-nine and thirty days, the former of which were called *deficient* months, and the latter *full* months. The lunar year, therefore, contained 354 days, falling short of the exact time of twelve lunations by about 8·8 hours. The first expedient adopted to reconcile the lunar and solar years seems to have been the addition of a month of thirty days to every second year. Two lunar years would thus contain 25 months, or 738 days, while two solar years, of $365\frac{1}{4}$ days each, contain $730\frac{1}{2}$ days. The difference of $7\frac{1}{2}$ days was still too great to escape observation; it was accordingly proposed by Cleostratus of Tenedos, who flourished shortly after the time of Thales, to omit the biennary intercalation every eighth year. In fact, the $7\frac{1}{2}$ days by which two lunar years exceeded two solar years, amounted to thirty days, or a full month, in eight years. By inserting, therefore, three additional months instead of four in every period of eight years, the coincidence between the solar and lunar year would have been exactly restored if the latter had contained only 354 days, inasmuch as the period contains $354 \times 8 + 3 \times 30 = 2922$ days, corresponding with eight solar years of $365\frac{1}{4}$ days each. But the true time of 99 lunations is 2923·528 days, which exceeds the above period by 1·528 days, or thirty-six hours and a few minutes. At the end of two periods, or sixteen years, the excess is three days, and at the end of 160 years, thirty days. It was therefore proposed to employ a period of 160 years, in which one of the intercalary months should be omitted; but as this period was too long to be of any practical use, it was never generally adopted. The common practice was to make occasional corrections as they became necessary, in order to preserve the relation between the octennial period and the state of the heavens; but these corrections being left to the care of incompetent persons, the calendar soon fell into great disorder, and no certain rule was followed till a new division of the year was proposed by Meton and Euctemon, which was immediately adopted in all the states and dependencies of Greece.

The mean motion of the moon in longitude, from the mean equinox, during a Julian year of 365·25 days (according to Hansen's *Tables de la Lune*, London, 1857, pages 15, 16) is, at the present date, $13 \times 360° + 477644''·409$; that of the sun being $360° + 27''·685$. Thus the corresponding relative mean geocentric motion of the moon from the sun is $12 \times 360° + 477616''·724$; and the duration of the mean synodic revolution of the moon, or lunar month, is therefore $\frac{360°}{12 \times 360° + 477616''·724} \times 365·25 = 29·530588$ days, or 29 days, 12 hours, 44 min. 2·8 sec.

The *Metonic Cycle*, which may be regarded as the *chef-d'œuvre* of ancient astronomy, is a period of nineteen solar years, after which the new moons again happen on the same days of the year. In nineteen solar years there are 235 lunations, a number which, on being divided by nineteen, gives twelve lunations for each year, with seven of a remainder, to be distributed among the years of the period. The period of Meton, therefore, consisted of twelve years containing twelve months each, and seven years containing thirteen months each; and these last formed the third, fifth, eighth, eleventh, thirteenth, sixteenth, and nineteenth years of the cycle. As it had now been discovered that the exact length of the lunation is a little more than twenty-nine and a half days, it became necessary to abandon the alternate succession of full and deficient months; and, in order to preserve a more accurate correspondence between the civil month and the lunation, Meton divided the cycle into 125 full months of thirty days, and 110 deficient months of twenty-nine days each. The number of days in the period was therefore 6940. In order to distribute the deficient months through the period in the most equable manner, the whole period may be regarded as consisting of 235 full months of thirty days, or of 7050 days, from which 110 days are to be deducted. This gives one day to be suppressed in sixty-four; so that if we suppose the months to contain each thirty days, and then omit every sixty-fourth day in reckoning from the beginning of the period, those months in which the omission takes place will, of course, be the deficient months.

The number of days in the period being known, it is easy to ascertain its accuracy both in respect of the solar and lunar motions. The exact length of nineteen solar years is $19 \times 365·2422 = 6939·6018$ days, or 6939 days 14 hours 26·592 minutes; hence the period, which is exactly 6940 days, exceeds nineteen revolutions of the sun by nine and a half hours nearly. On the other hand, the exact time of a synodic revolution of the moon is 29·530588 days; 235 lunations, therefore, contain $235 \times 29·530588 = 6939·68818$ days, or 6939 days 16 hours 31 minutes, so that the period exceeds 235 lunations by only seven and a half hours.

After the Metonic cycle had been in use about a century, a correction was proposed by Calippus. At the end of four cycles, or seventy-six years, the accumulation of the seven and a half hours of difference between the cycle and 235 lunations amounts to thirty hours, or one whole day and six hours. Calippus, therefore, proposed to quadruple the period of Meton, and deduct one day at the end of that time by changing one of the full months into a deficient month. The period of Calippus, therefore, consisted of three Metonic cycles of 6940 days each, and a period of 6939 days; and its error in respect of the moon, consequently, amounted only to six hours, or to one day in 304 years. This period exceeds seventy-six true solar years by fourteen hours and a quarter nearly, but coincides exactly with seventy-six Julian years; and in the time of Calippus the length of the solar year was almost universally supposed to be exactly $365\frac{1}{4}$ days. The Calippic period is frequently referred to as a date by Ptolemy.

ECCLESIASTICAL CALENDAR.—The ecclesiastical calendar, which is adopted in all the Catholic, and most of the Protestant countries of Europe, is luni-solar, being regulated partly by the solar, and partly by the lunar year,—a circumstance which gives rise to the distinction between the movable and immovable feasts. So early as the 2d century of our era, great disputes had arisen among the Christians respecting the proper time of celebrating Easter, which governs all the other movable feasts. The Jews celebrated their passover on the 14th day of the *first month*, that is to say, the lunar month of which the fourteenth day either falls on, or next follows, the day of the vernal equinox.

Most Christian sects agreed that Easter should be celebrated on a Sunday. Others followed the example of the Jews, and adhered to the 14th of the moon; but these, as usually happened to the minority, were accounted heretics, and received the appellation of Quartodecimans. In order to terminate dissensions, which produced both scandal and schism in the church, the Council of Nice, which was held in the year 325, ordained that the celebration of Easter should thenceforth always take place on the Sunday which immediately follows the full moon that happens upon, or next after, the day of the vernal equinox. Should the 14th of the moon, which is regarded as the day of full moon, happen on a Sunday, the celebration of Easter was deferred to the Sunday following, in order to avoid concurrence with the Jews and the above-mentioned heretics. The observance of this rule renders it necessary to reconcile three periods which have no common measure, namely, the week, the lunar month, and the solar year; and as this can only be done approximately, and within certain limits, the determination of Easter is an affair of considerable nicety and complication. It is to be regretted that the reverend fathers who formed the Council of Nice were not advised to abandon the moon altogether, and appoint Easter to be celebrated on the first or second Sunday of April. The ecclesiastical calendar would in that case have possessed all the simplicity and uniformity of the civil calendar, which only requires the adjustment of the civil to the solar year; but they were probably not sufficiently versed in astronomy to be aware of the practical difficulties which their regulation had to encounter.

Dominical Letter.—The first problem which the construction of the calendar presents is to connect the week with the year, or to find the day of the week corresponding to a given day of any year of the era. As the number of days in the week and the number in the year are prime to one another, two successive years cannot begin with the same day; for if a common year begins, for example, with Sunday, the following year will begin with Monday, and if a leap year begins with Sunday, the year following will begin with Tuesday. For the sake of greater generality, the days of the week are denoted by the first seven letters of the alphabet, A, B, C, D, E, F, G, which are placed in the calendar beside the days of the year, so that A stands opposite the first day of January, B opposite the second, and so on to G, which stands opposite the seventh; after which A returns to the eighth, and so on through the 365 days of the year. Now, if one of the days of the week, Sunday for example, is represented by E, Monday will be represented by F, Tuesday by G, Wednesday by A, and so on; and every Sunday through the year will have the same character E, every Monday F, and so with regard to the rest. The letter which denotes Sunday is called the *Dominical Letter*, or the *Sunday Letter;* and when the dominical letter of the year is known, the letters which respectively correspond to the other days of the week become known at the same time.

Solar Cycle.—In the Julian calendar the dominical letters are readily found by means of a short cycle, in which they recur in the same order without interruption. The number of years in the intercalary period being four, and the days of the week being seven, their product is $4 \times 7 = 28$; twenty-eight years is therefore a period which includes all the possible combinations of the days of the week with the commencement of the year. This period is called the *Solar Cycle*, or the *Cycle of the Sun*, and restores the first day of the year to the same day of the week. At the end of the cycle the dominical letters return again in the same order on the same days of the month; hence a table of dominical letters, constructed for twenty-eight years will serve to show the dominical letter of any given year from the commencement of the era to the reformation. The cycle, though probably not invented before the time of the Council of Nice, is regarded as having commenced nine years before the era, so that the year *one* was the tenth of the solar cycle. To find the year of the cycle, we have therefore the following rule:—*Add nine to the date, divide the sum by twenty-eight; the quotient is the number of cycles elapsed, and the remainder is the year of the cycle.* Should there be no remainder, the proposed year is the twenty-eighth or last of the cycle. This rule is conveniently expressed by the formula $\left(\frac{x+9}{28}\right)_r$, in which x denotes the date, and the symbol r denotes that the remainder, which arises from the division of $x+9$ by 28, is the number required. Thus, for 1840, we have $\frac{1840+9}{28} = 66\frac{1}{28}$; therefore $\left(\frac{1840+9}{28}\right)_r = 1$, and the year 1840 is the first of the solar cycle. In order to make use of the solar cycle in finding the dominical letter, it is necessary to know that the first year of the Christian era began with Saturday. The dominical letter of that year, which was the tenth of the cycle, was consequently B. The following year, or the 11th of the cycle, the letter was A; then G. The fourth year was bissextile, and the dominical letters were F, E; the following year D, and so on. In this manner it is easy to find the dominical letter belonging to each of the twenty-eight years of the cycle. But at the end of a century the order is interrupted in the Gregorian calendar by the secular suppression of the leap year; hence the cycle can only be employed during a century. In the reformed calendar the intercalary period is four hundred years, which number being multiplied by seven, gives two thousand eight hundred years as the interval in which the coincidence is restored between the days of the year and the days of the week. This long period, however, may be reduced to four hundred years; for since the dominical letter goes back five places every four years, its variation in four hundred years, in the Julian calendar, was five hundred places, which is equivalent to only three places (for five hundred divided by seven leaves three); but the Gregorian calendar suppresses exactly three intercalations in four hundred years, so that after four hundred years the dominical letters must again return in the same order.

Hence the following table of dominical letters for four hundred years will serve to show the dominical letter of any year in the Gregorian calendar for ever. It contains four columns of letters, each column serving for a century. In order to find the column from which the letter in any given case is to be taken, strike off the two last figures of the date, divide the preceding figures by four, and the remainder will indicate the column. The symbol X, employed in the formula at the top of the column, denotes the number of centuries, that is, the figures remaining after the last two have been struck off. For example, required the dominical letter of the year 1839? In this case $X = 18$, therefore $\left(\frac{X}{4}\right)_r = 2$; and in the second column of letters, opposite 39, in the table we find F, which is the letter of the proposed year.

It deserves to be remarked, that as the dominical letter of the first year of the era was B, the first column of the following table will give the dominical letter of every year from the commencement of the era to the reformation. For this purpose divide the date by 28, and the letter opposite the remainder, in the first column of figures, is the dominical letter of the year. For example, supposing the date to be 1148. On dividing by 28, the remainder is 0, or 28; and opposite 28, in the first column of letters, we find D, C, the dominical letters of the year 1148.

TABLE I.—*Dominical Letters.*

Years of the Century.	$\left(\frac{X}{4}\right)_r=1$	$\left(\frac{X}{4}\right)_r=2$	$\left(\frac{X}{4}\right)_r=3$	$\left(\frac{X}{4}\right)_r=0$
0	C	E	G	B, A
1 29 57 85	B	D	F	G
2 30 58 86	A	C	E	F
3 31 59 87	G	B	D	E
4 32 60 88	F, E	A, G	C, B	D, C
5 33 61 89	D	F	A	B
6 34 62 90	C	E	G	A
7 35 63 91	B	D	F	G
8 36 64 92	A, G	C, B	E, D	F, E
9 37 65 93	F	A	C	D
10 38 66 94	E	G	B	C
11 39 67 95	D	F	A	B
12 40 68 96	C, B	E, D	G, F	A, G
13 41 69 97	A	C	E	F
14 42 70 98	G	B	D	E
15 43 71 99	F	A	C	D
16 44 72	E, D	G, F	B, A	C, B
17 45 73	C	E	G	A
18 46 74	B	D	F	G
19 47 75	A	C	E	F
20 48 76	G, F	B, A	D, C	E, D
21 49 77	E	G	B	C
22 50 78	D	F	A	B
23 51 79	C	E	G	A
24 52 80	B, A	D, C	F, E	G, F
25 53 81	G	B	D	E
26 54 82	F	A	C	D
27 55 83	E	G	B	C
28 56 84	D, C	F, E	A, G	B, A

TABLE II.—*The Day of the Week.*

Month.	Dominical Letter						
Jan. Oct.	A	B	C	D	E	F	G
Feb. Mar. Nov.	D	E	F	G	A	B	C
April July	G	A	B	C	D	E	F
May	B	C	D	E	F	G	A
June	E	F	G	A	B	C	D
August	C	D	E	F	G	A	B
Sept. Dec.	F	G	A	B	C	D	E

1	8	15	22	29	Sun.	Sat.	Frid.	Thur.	Wed.	Tues.	Mon.
2	9	16	23	30	Mon.	Sun.	Sat.	Frid.	Thur.	Wed.	Tues.
3	10	17	24	31	Tues.	Mon.	Sun.	Sat.	Frid.	Thur.	Wed.
4	11	18	25		Wed.	Tues.	Mon.	Sun.	Sat.	Frid.	Thur.
5	12	19	26		Thur.	Wed.	Tues.	Mon.	Sun.	Sat.	Frid.
6	13	20	27		Frid.	Thur.	Wed.	Tues.	Mon.	Sun.	Sat.
7	14	21	28		Sat.	Frid.	Thur.	Wed.	Tues.	Mon.	Sun.

Lunar Cycle and Golden Number.—In connecting the lunar month with the solar year, the framers of the ecclesiastical calendar adopted the period of Meton, or lunar cycle, which they supposed to be exact. A different arrangement has, however, been followed with respect to the distribution of the months. The lunations are supposed to consist of twenty-nine and thirty days alternately, or the lunar year of 354 days; and in order to make up nineteen solar years, six embolismic or intercalary months, of thirty days each, are introduced in the course of the cycle, and one of twenty-nine days is added at the end. This gives 19 × 354 + 6 × 30 + 29 = 6935 days, to be distributed among 235 lunar months. But every leap year one day must be added to the lunar month in which the 29th of February is included. Now if leap year happens on the first, second, or third year of the period, there will be five leap years in the period, but only four when the first leap year falls on the fourth. In the former case the number of days in the period becomes 6940 and in the latter 6939. The mean length of the cycle is therefore 6939¾ days, agreeing exactly with nineteen Julian years.

By means of the lunar cycle the new moons of the calendar were indicated before the reformation. As the cycle restores these phenomena to the same days of the civil month, they will fall on the same days in any two years which occupy the same place in the cycle; consequently a table of the moon's phases for 19 years will serve for any year whatever when we know its number in the cycle. This number is called the *Golden Number*, either because it was so termed by the Greeks, or because it was usual to mark it with red letters in the calendar. The Golden Numbers were introduced into the calendar about the year 530, but disposed as they would have been if they had been inserted at the time of the Council of Nice. The cycle is supposed to commence with the year in which the new moon falls on the 1st of January, which took place the year preceding the commencement of our era. Hence, to find the Golden Number N, for any year x, we have $N = \left(\frac{x+1}{19}\right)_r$, which gives the following rule: *Add* 1 *to the date, divide the sum by* 19; *the quotient is the number of cycles elapsed, and the remainder is the Golden Number.* When the remainder is 0, the proposed year is of course the last or 19th of the cycle. It ought to be remarked that the new moons, determined in this manner, may differ from the astronomical new moons sometimes as much as two days. The reason is, that the sum of the solar and lunar inequalities, which are compensated in the whole period, may amount in certain cases to 10°, and thereby cause the new moon to arrive on the second day before or after its mean time.

Dionysian Period.—The cycle of the sun brings back the days of the month to the same day of the week; the lunar cycle restores the new moons to the same day of the month; therefore 28 × 19 = 532 years, includes all the variations in respect of the new moons and the dominical letters, and is consequently a period after which the new moons again occur on the same day of the month and the same day of the week. This is called the *Dionysian* or *Great Paschal Period*, from its having been employed by Dionysius Exiguus, familiarly styled "Denys the Little," in determining Easter Sunday. It was, however, first proposed by Victorius of Aquitain, who had been appointed by Pope Hilary to revise and correct the church calendar. Hence it is also called the *Victorian Period.* It continued in use till the Gregorian reformation.

Cycle of Indiction.—Besides the solar and lunar cycles, there is a third of 15 years, called the cycle of indiction, frequently employed in the computations of chronologists. This period is not astronomical, like the two former, but has reference to certain judicial acts which took place at stated epochs under the Greek emperors. Its commencement is referred to the 1st of January of the year 313 of the common era. By extending it backwards, it will be found that the first of the era was the fourth of the cycle of indiction. The number of any year in this cycle will therefore be given by the formula $\left(\frac{x+3}{15}\right)_r$, that is to say, *add 3 to the date, divide the sum by 15, and the remainder is the year of the indiction.* When the remainder is 0, the proposed year is the fifteenth of the cycle.

Julian Period.—The Julian period, proposed by the celebrated Joseph Scaliger as an universal measure of chronology, is formed by taking the continued product of the three cycles of the sun, of the moon, and of the indiction, and is consequently 28 × 19 × 15 = 7980

years. In the course of this long period no two years can be expressed by the same numbers in all the three cycles. Hence, when the number of any proposed year in each of the cycles is known, its number in the Julian period can be determined by the resolution of a very simple problem of the indeterminate analysis. It is unnecessary, however, in the present case to exhibit the general solution of the problem, because when the number in the period corresponding to any one year in the common era has been ascertained, it is easy to establish the correspondence for all other years, without having again recourse to the direct solution of the problem. We shall therefore find the number of the Julian period corresponding to the first of our era.

We have already seen that the year 1 of the era had 10 for its number in the solar cycle, 2 in the lunar cycle, and 4 in the cycle of indiction; the question is therefore to find a number such, that when it is divided by the three numbers 28, 19, and 15 respectively, the three quotients shall be 10, 2, and 4.

Let x, y, and z be the three quotients of the divisions; the number sought will then be expressed by $28x + 10$, by $19y + 2$, or by $15z + 4$. Hence the two equations

$$28x + 10 = 19y + 2 = 15z + 4.$$

To resolve the equation $28x + 10 = 19y + 2$, or $y = x + \frac{9x + 8}{19}$, let $m = \frac{9x + 8}{19}$, we have then $x = 2m + \frac{m - 8}{9}$.

Let $\frac{m - 8}{9} = m'$; then $m = 9m' + 8$; hence

$$x = 18m' + 16 + m' = 19m' + 16 \text{.........} (1).$$

Again, since $28x + 10 = 15z + 4$, we have

$$15z = 28x + 6, \text{ or } z = 2x - \frac{2x - 6}{15}.$$

Let $\frac{2x - 6}{15} = n$; then $2x = 15n + 6$, and $x = 7n + 3 + \frac{n}{2}$.

Let $\frac{n}{2} = n'$; then $n' = 2n'$; consequently

$$x = 14n' + 3 + n' = 15n' + 3 \text{...............} (2).$$

Equating the above two values of x, we have

$$15n' + 3 = 19m' + 16; \text{ whence } n' = m' + \frac{4m' + 13}{15}.$$

Let $\frac{4m' + 13}{15} = p$; we have then

$$4m' = 15p - 13, \text{ and } m' = 4p - \frac{p + 13}{4}.$$

Let $\frac{p + 13}{4} = p'$; then $p = 4p' - 13$;

$$\text{whence } m' = 16p' - 52 - p' = 15p' - 52.$$

Now in this equation p' may be any number whatever, provided $15p'$ exceed 52. The smallest value of p' (which is the one here wanted) is therefore 4; for $15 \times 4 = 60$. Assuming therefore $p' = 4$, we have $m' = 60 - 52 = 8$; and consequently, since $x = 19m' + 16$, $x = 19 \times 8 + 16 = 168$. The number required is consequently $28 \times 168 + 10 = 4714$.

Having found the number 4714 for the first of the era, the correspondence of the years of the era and of the period is as follows:—

Era,	1,	2,	3,...	x,
Period,	4714,	4715,	4716,...	$4713 + x$;

from which it is evident, that if we take P to represent the year of the Julian period, and x the corresponding year of the Christian era, we shall have

$$P = 4713 + x, \text{ and } x = P - 4713.$$

With regard to the numeration of the years previous to the commencement of the era, the practice is not uniform. Chronologists, in general, reckon the year preceding the first of the era -1, the next preceding -2, and so on. In this case

Era,	-1,	-2,	-3,...	$-x$,
Period,	4713,	4712,	4711,..	$4714 - x$;

whence

$$P = 4714 - x, \text{ and } x = 4714 - P.$$

But astronomers, in order to preserve the uniformity of computation, make the series of years proceed without interruption, and reckon the year preceding the first of the era 0. Thus

Era,	0,	-1,	-2,...	$-x$,
Period,	4713,	4712,	4711,...	$4713 - x$.

therefore, in this case

$$P = 4713 - x, \text{ and } x = 4713 - P.$$

Reformation of the Calendar.—The ancient church calendar was founded on two suppositions, both erroneous, namely, that the year contains $365\frac{1}{4}$ days, and that 235 lunations are exactly equal to nineteen solar years. It could not therefore long continue to preserve its correspondence with the seasons, or to indicate the days of the new moons with the same accuracy. About the year 730 the venerable Bede had already perceived the anticipation of the equinoxes, and remarked that these phenomena then took place about three days earlier than at the time of the Council of Nice. Five centuries after the time of Bede, the divergence of the true equinox from the 21st of March, which now amounted to seven or eight days, was pointed out by John of Sacrobosco, in a work published under the title *De Anni Ratione;* and by Roger Bacon, in a treatise *De Reformatione Calendarii*, which, though never published, was transmitted to the Pope. These works were probably little regarded at the time; but as the errors of the calendar went on increasing, and the true length of the year, in consequence of the progress of astronomy, became better known, the project of a reformation was again revived in the 15th century; and in 1474 Pope Sextus IV. invited Regiomontanus, the most celebrated astronomer of the age, to Rome, to superintend the reconstruction of the calendar. The premature death of Regiomontanus caused the design to be suspended for the time; but in the following century numerous memoirs appeared on the subject, among the authors of which were Stöffler, Albert Pighius, John Schöner, Lucas Gauricus, and other mathematicians of celebrity. At length Pope Gregory XIII. perceiving that the measure was likely to confer a great eclat on his pontificate, undertook the long-desired reformation; and having found the Governments of the principal Catholic states ready to adopt his views, he issued a brief in the month of March 1582, in which he abolished the use of the ancient calendar, and substituted that which has since been received in almost all Christian countries under the name of the *Gregorian Calendar* or *New Style*. The author of the system adopted by Gregory was Aloysius Lilius, or Luigi Lilio Ghiraldi, a learned astronomer and physician of Naples, who died, however, before its introduction; but the individual who most contributed to give the ecclesiastical calendar its present form, and who was charged with all the calculations necessary for its verification, was Clavius, by whom it was completely developed and explained in a great folio treatise of 800 pages, published in 1603, the title of which is given at the end of this article.

It has already been mentioned that the error of the Julian year was corrected in the Gregorian calendar by the suppression of three intercalations in 400 years. In order to restore the commencement of the year to the same place in the seasons that it had occupied at the time of the Council of Nice, Gregory directed the day following the feast of St Francis, that is to say the 5th of October, to be reckoned the 15th of that month. By this regulation the vernal equinox which then happened on the 11th of March was restored to the 21st. From 1582 to 1700 the difference between the old and new style continued to be ten days; but 1700 being a leap year in the Julian calendar, and a common year in the Gregorian, the difference of the styles during the 18th century was eleven days. The year 1800 was also common in the new calendar, and, consequently, the difference in the present century is twelve days. From 1900 to 2100 inclusive it will be thirteen days.

The restoration of the equinox to its former place in the year, and the correction of the intercalary period, were attended with no difficulty; but Lilius had also to adapt the lunar year to the new rule of intercalation. The lunar

cycle contained 6939 days 18 hours, whereas the exact time of 235 lunations, as we have already seen, is 235 × 29·530588 = 6939 days 16 hours 31 minutes. The difference, which is 1 hour 29 minutes, amounts to a day in 308 years, so that at the end of this time the new moons occur one day earlier than they are indicated by the golden numbers. During the 1257 years that elapsed between the Council of Nice and the reformation, the error had accumulated to four days, so that the new moons which were marked in the calendar as happening, for example, on the 5th of the month, actually fell on the 1st. It would have been easy to correct this error by placing the golden numbers four lines higher in the new calendar; and the suppression of the ten days had already rendered it necessary to place them ten lines lower, and to carry those which belonged, for example, to the 5th and 6th of the month, to the 15th and 16th. But, supposing this correction to have been made, it would have again become necessary, at the end of 308 years, to advance them one line higher, in consequence of the accumulation of the error of the cycle to a whole day. On the other hand, as the golden numbers were only adapted to the Julian calendar, every omission of the centenary intercalation would require them to be placed one line lower, opposite the 6th, for example, instead of the 5th of the month; so that, generally speaking, the places of the golden numbers would have to be changed every century. On this account Lilius thought fit to reject the golden numbers from the calendar, and supply their place by another set of numbers called *Epacts*, the use of which we shall now proceed to explain.

Epacts.—Epact is a word of Greek origin, employed in the calendar to signify the moon's age at the beginning of the year. The common solar year containing 365 days, and the lunar year only 354 days, the difference is eleven; whence, if a new moon fall on the 1st of January in any year, the moon will be eleven days old on the first day of the following year, and twenty-two days on the first of the third year. The numbers eleven and twenty-two are therefore the epacts of those years respectively. Another addition of eleven gives thirty-three for the epact of the fourth year; but in consequence of the insertion of the intercalary month in each third year of the lunar cycle, this epact is reduced to three. In like manner the epacts of all the following years of the cycle are obtained by successively adding eleven to the epact of the former year, and rejecting thirty as often as the sum exceeds that number. They are therefore connected with the golden numbers by the formula $\left(\frac{11\,n}{30}\right)_r$, in which n is any whole number; and for a whole lunar cycle (supposing the first epact to be 11), they are as follows: 11, 22, 3, 14, 25, 6, 17, 28, 9, 20, 1, 12, 23, 4, 15, 26, 7, 18, 29. But the order is interrupted at the end of the cycle; for the epact of the following year, found in the same manner, would be 29 + 11 = 40 or 10, whereas it ought again to be 11 to correspond with the moon's age and the golden number 1. The reason of this is, that the intercalary month, inserted at the end of the cycle, contains only twenty-nine days instead of thirty; whence, after 11 has been added to the epact of the year corresponding to the golden number 19, we must reject twenty-nine instead of thirty, in order to have the epact of the succeeding year; or, which comes to the same thing, we must add twelve to the epact of the last year of the cycle, and then reject thirty as before.

This method of forming the epacts might have been continued indefinitely if the Julian intercalation had been followed without correction, and the cycle been perfectly exact; but as neither of these suppositions is true, two equations or corrections must be applied, one depending on the error of the Julian year, which is called the solar equation; the other on the error of the lunar cycle, which is called the lunar equation. The solar equation occurs three times in 400 years, namely, in every secular year which is not a leap year; for in this case the omission of the intercalary day causes the new moons to arrive one day later in all the following months, so that the moon's age at the end of the month is one day less than it would have been if the intercalation had been made, and the epacts must accordingly be all diminished by unity. Thus the epacts 11, 22, 3, 14, &c., become 10, 21, 2, 13, &c. On the other hand, when the time by which the new moons anticipate the lunar cycle amounts to a whole day, which, as we have seen, it does in 308 years, the new moons will arrive one day earlier, and the epacts must consequently be increased by unity. Thus the epacts 11, 22, 3, 14, &c., in consequence of the lunar equation, become 12, 23, 4, 15, &c. In order to preserve the uniformity of the calendar, the epacts are changed only at the commencement of a century; the correction of the error of the lunar cycle is therefore made at the end of 300 years. In the Gregorian calendar this error is assumed to amount to one day in 312½ years, or eight days in 2500 years, an assumption which requires the line of epacts to be changed seven times successively at the end of each period of 300 years, and once at the end of 400 years; and, from the manner in which the epacts were disposed at the reformation, it was found most correct to suppose one of the periods of 2500 years to terminate with the year 1800.

The years in which the solar equation occurs, counting from the reformation, are 1700, 1800, 1900, 2100, 2200, 2300, 2500, &c. Those in which the lunar equation occurs are 1800, 2100, 2400, 2700, 3000, 3300, 3600, 3900, after which, 4300, 4600, and so on. When the solar equation occurs, the epacts are diminished by unity; when the lunar equation occurs, the epacts are augmented by unity; and when both equations occur together, as in 1800, 2100, 2700, &c., they compensate each other, and the epacts are not changed.

In consequence of the solar and lunar equations, it is evident that the epact, or moon's age at the beginning of the year, must, in the course of centuries, have all different values from one to thirty inclusive, corresponding to the days in a full lunar month. Hence, for the construction of a perpetual calendar, there must be thirty different sets or lines of epacts. These are exhibited in the subjoined table (Table III.) called the *Extended Table of Epacts*, which is constructed in the following manner. The series of golden numbers is written in a line at the top of the table, and under each golden number is a column of thirty epacts, arranged in the order of the natural numbers, beginning at the bottom and proceeding to the top of the column. The first column, under the golden number 1, contains the epacts, 1, 2, 3, 4, &c., to 30 or 0. The second column, corresponding to the following year in the lunar cycle, must have all its epacts augmented by 11; the lowest number, therefore, in the column is 12, then 13, 14, 15, and so on. The third column, corresponding to the golden number 3, has for its first epact 12 + 11 = 23; and in the same manner all the nineteen columns of the table are formed. Each of the thirty lines of epacts is designated by a letter of the alphabet, which serves as its index or argument. The order of the letters, like that of the numbers, is from the bottom of the column upwards.

In the tables of the church calendar the epacts are usually printed in Roman numerals, excepting the last, which is designated by an asterisk (*), used as an indefinite symbol to denote 30 or 0, and 25, which in the last eight columns is expressed in Arabic characters, for a reason that will immediately be explained. In the table

here given, this distinction is made by means of an accent placed over the last figure.

At the reformation the epacts were given by the line D. The year 1600 was a leap year; the intercalation accordingly took place as usual, and there was no interruption in the order of the epacts; the line D was employed till 1700. In that year the omission of the intercalary day rendered it necessary to diminish the epacts by unity, or to pass to the line C. In 1800 the solar equation again occurred, in consequence of which it was necessary to descend one line to have the epacts diminished by unity; but in this year the lunar equation also occurred, the anticipation of the new moons having amounted to a day; the new moons accordingly happened a day earlier, which rendered it necessary to take the epacts in the next higher line. There was, consequently, no alteration; the two equations destroyed each other. The line of epacts belonging to the present century is therefore C. In 1900 the solar equation occurs, after which the line is B. The year 2000 is a leap year, and there is no alteration. In 2100 the equations again occur together and destroy each other, so that the line B will serve three centuries, from 1900 to 2200. From that year to 2300 the line will be A. In this manner the line of epacts belonging to any given century is easily found, and the method of proceeding is obvious. When the solar equation occurs alone, the line of epacts is changed to the next lower in the table; when the lunar equation occurs alone, the line is changed to the next higher; when both equations occur together, no change takes place. In order that it may be perceived at once to what centuries the different lines of epacts respectively belong, they have been placed in a column on the left hand side of the following table.

TABLE III.—*Extended Table of Epacts.*

Years.	Index.	Golden Numbers.																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1700 1800 8700	C	*	11	22	3	14	25	6	17	28	9	20	1	12	23	4	15	26	7	18
1900 2000 2100	B	29	10	21	2	13	24	5	16	27	8	19	*	11	22	3	14	25′	6	17
2200 2400	A	28	9	20	1	12	23	4	15	26	7	18	29	10	21	2	13	24	5	16
2300 2500	u	27	8	19	*	11	22	3	14	25	6	17	28	9	20	1	12	23	4	15
2600 2700 2800	t	26	7	18	29	10	21	2	13	24	5	16	27	8	19	*	11	22	3	14
2900 3000	s	25	6	17	28	9	20	1	12	23	4	15	26	7	18	29	10	21	2	13
3100 3200 3300	r	24	5	16	27	8	19	*	11	22	3	14	25′	6	17	28	9	20	1	12
3400 3600	q	23	4	15	26	7	18	29	10	21	2	13	24	5	16	27	8	19	*	11
3500 3700	p	22	3	14	25	6	17	28	9	20	1	12	23	4	15	26	7	18	29	10
3800 3900 4000	n	21	2	13	24	5	16	27	8	19	*	11	22	3	14	25′	6	17	28	9
4100	m	20	1	12	23	4	15	26	7	18	29	10	21	2	13	24	5	16	27	8
4200 4300 4400	l	19	*	11	22	3	14	25	6	17	28	9	20	1	12	23	4	15	26	7
4500 4600	k	18	29	10	21	2	13	24	5	16	27	8	19	*	11	22	3	14	25′	6
4700 4800 4900	i	17	28	9	20	1	12	23	4	15	26	7	18	29	10	21	2	13	24	5
5000 5200	h	16	27	8	19	*	11	22	3	14	25	6	17	28	9	20	1	12	23	4
5100 5300	g	15	26	7	18	29	10	21	2	13	24	5	16	27	8	19	*	11	22	3
5400 5500 5600	f	14	25	6	17	28	9	20	1	12	23	4	15	26	7	18	29	10	21	2
5700 5800	e	13	24	5	16	27	8	19	*	11	22	3	14	25′	6	17	28	9	20	1
5900 6000 6100	d	12	23	4	15	26	7	18	29	10	21	2	13	24	5	16	27	8	19	*
6200 6400	c	11	22	3	14	25	6	17	28	9	20	1	12	23	4	15	26	7	18	29
6300 6500	b	10	21	2	13	24	5	16	27	8	19	*	11	22	3	14	25′	6	17	28
6600 6800	a	9	20	1	12	23	4	15	26	7	18	29	10	21	2	13	24	5	16	27
6700 6900	P	8	19	*	11	22	3	14	25	6	17	28	9	20	1	12	23	4	15	26
7000 7100 7200	N	7	18	29	10	21	2	13	24	5	16	27	8	19	*	11	22	3	14	25′
7300 7400	M	6	17	28	9	20	1	12	23	4	15	26	7	18	29	10	21	2	13	24
7500 7600 7700	H	5	16	27	8	19	*	11	22	3	14	25	6	17	28	9	20	1	12	23
7800 8000	G	4	15	26	7	18	29	10	21	2	13	24	5	16	27	8	19	*	11	22
7900 8100	F	3	14	25	6	17	28	9	20	1	12	23	4	15	26	7	18	29	10	21
8200 8300 8400	E	2	13	24	5	16	27	8	19	*	11	22	3	14	25′	6	17	28	9	20
1500 1600 8500	D	1	12	23	4	15	26	7	18	29	10	21	2	13	24	5	16	27	8	19

The use of the epacts is to show the days of the new moons, and consequently the moon's age on any day of the year. For this purpose they are placed in the calendar (Table IV.) along with the days of the month and dominical letters, in a retrograde order, so that the asterisk stands beside the 1st of January, 29 beside the 2nd, 28 beside the 3rd, and so on to 1, which corresponds to the 30th. After this comes the asterisk, which corresponds to the 31st of January, then 29, which belongs to the 1st of February, and so on to the end of the year. The reason of this distribution is evident. If the last lunation of any year ends, for example, on the 2nd of December, the new moon falls on the 3rd; and the moon's age on the 31st, or at the end of the year, is twenty-nine days. The epact of the following year is therefore twenty-nine. Now that lunation having commenced on the 3rd of December, and consisting of thirty days, will end on the 1st of January. The 2nd of January is therefore the day of the new moon, which is indicated by the epact twenty-nine. In like manner, if the new moon fell on the 4th of December, the epact of the following year would be twenty-eight, which, to indicate the day of next new moon, must correspond to the 3rd of January.

When the epact of the year is known, the days on which the new moons occur throughout the whole year are shown by Table IV., which is called the *Gregorian Calendar of Epacts.* For example, the golden number of the year 1832, is $\left(\frac{1832+1}{19}\right)_r = 9$, and the epact, as found in Table III., is twenty-eight. This epact occurs at the 3rd of January, the 2nd of February, the 3rd of March, the 2nd of April, the 1st of May, &c.; and these days are consequently the days of the ecclesiastical new moons in 1832. The astronomical new moons generally take place one or two days, sometimes even three days, earlier than those of the calendar.

TABLE IV.—*Gregorian Calendar.*

Days	January		February		March		April		May		June		July		August		September		October		November		December	
	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L	E	L
1	*	A	29	D	*	D	29	G	28	B	27	E	26	G	25 24	C	23	F	22	A	21	D	20	F
2	29	B	28	E	29	E	28	A	27	C	25'26	F	25'25	A	23	D	22	G	21	B	20	E	19	G
3	28	C	27	F	28	F	27	B	26	D	25 24	G	24	B	22	E	21	A	20	C	19	F	18	A
4	27	D	25'26	G	27	G	25'26	C	25'25	E	23	A	23	C	21	F	20	B	19	D	18	G	17	B
5	26	E	25 24	A	26	A	25 24	D	24	F	22	B	22	D	20	G	19	C	18	E	17	A	16	C
6	25'25	F	23	B	25'25	B	23	E	23	G	21	C	21	E	19	A	18	D	17	F	16	B	15	D
7	24	G	22	C	24	C	22	F	22	A	20	D	20	F	18	B	17	E	16	G	15	C	14	E
8	23	A	21	D	23	D	21	G	21	B	19	E	19	G	17	C	16	F	15	A	14	D	13	F
9	22	B	20	E	22	E	20	A	20	C	18	F	18	A	16	D	15	G	14	B	13	E	12	G
10	21	C	19	F	21	F	19	B	19	D	17	G	17	B	15	E	14	A	13	C	12	F	11	A
11	20	D	18	G	20	G	18	C	18	E	16	A	16	C	14	F	13	B	12	D	11	G	10	B
12	19	E	17	A	19	A	17	D	17	F	15	B	15	D	13	G	12	C	11	E	10	A	9	C
13	18	F	16	B	18	B	16	E	16	G	14	C	14	E	12	A	11	D	10	F	9	B	8	D
14	17	G	15	C	17	C	15	F	15	A	13	D	13	F	11	B	10	E	9	G	8	C	7	E
15	16	A	14	D	16	D	14	G	14	B	12	E	12	G	10	C	9	F	8	A	7	D	6	F
16	15	B	13	E	15	E	13	A	13	C	11	F	11	A	9	D	8	G	7	B	6	E	5	G
17	14	C	12	F	14	F	12	B	12	D	10	G	10	B	8	E	7	A	6	C	5	F	4	A
18	13	D	11	G	13	G	11	C	11	E	9	A	9	C	7	F	6	B	5	D	4	G	3	B
19	12	E	10	A	12	A	10	D	10	F	8	B	8	D	6	G	5	C	4	E	3	A	2	C
20	11	F	9	B	11	B	9	E	9	G	7	C	7	E	5	A	4	D	3	F	2	B	1	D
21	10	G	8	C	10	C	8	F	8	A	6	D	6	F	4	B	3	E	2	G	1	C	*	E
22	9	A	7	D	9	D	7	G	7	B	5	E	5	G	3	C	2	F	1	A	*	D	29	F
23	8	B	6	E	8	E	6	A	6	C	4	F	4	A	2	D	1	G	*	B	29	E	28	G
24	7	C	5	F	7	F	5	B	5	D	3	G	3	B	1	E	*	A	29	C	28	F	27	A
25	6	D	4	G	6	G	4	C	4	E	2	A	2	C	*	F	29	B	28	D	27	G	26	B
26	5	E	3	A	5	A	3	D	3	F	1	B	1	D	29	G	28	C	27	E	25'26	A	25'25	C
27	4	F	2	B	4	B	2	E	2	G	*	C	*	E	28	A	27	D	26	F	25 24	B	24	D
28	3	G	1	C	3	C	1	F	1	A	29	D	29	F	27	B	25'26	E	25'25	G	23	C	23	E
29	2	A			2	D	*	G	*	B	28	E	28	G	26	C	25 24	F	24	A	22	D	22	F
30	1	B			1	E	29	A	29	C	27	F	27	A	25'25	D	23	G	23	B	21	E	21	G
31	*	C			*	F			28	D			25'26	B	24	E			22	C			19'20	A

There are some artifices employed in the construction of this table, to which it is necessary to pay attention. The thirty epacts correspond to the thirty days of a full lunar month; but the lunar months consist of twenty-nine and thirty days alternately, therefore in six months of the year the thirty epacts must correspond only to twenty-nine days. For this reason the epacts twenty-five and twenty-four are placed together, so as to belong only to one day in the months of February, April, June, August, September, and November, and in the same months another 25′, distinguished by an accent, or by being printed in a different character, is placed beside 26, and belongs to the same day. The reason for doubling the 25 was to prevent the new moons from being indicated in the calendar as happening twice on the same day in the course of the lunar cycle, a thing which actually cannot take place. For example, if we observe the line B in Table III., we shall see that it contains both the epacts twenty-four and twenty-five, so that if these correspond to the same day of the month, two new moons would be indicated as happening on that day within nineteen years. Now the three epacts 24, 25, 26, can never occur in the same line; therefore in those lines in which 24 and 25 occur, the 25 is accented, and placed in the calendar beside 26. When 25 and 26 occur in the same line of epacts, the 25 is not accented, and in the calendar stands beside 24. The lines of epacts in which 24 and 25 both occur, are those which are marked by one of the eight letters *b*, *e*, *k*, *n*, *r*, B, E, N, in all of which 25′ stands in a column corresponding to a golden number higher than 11. There are also eight lines in which 25 and 26 occur, namely, *c*, *f*, *l*, *p*, *s*, C, F, P. In the other 14 lines, 25 either does not occur at all, or it occurs in a line in which neither 24 nor 26 is found. From this it appears, that if the golden number of the year exceeds 11, the epact 25, in six months of the year, must correspond to the same day in the calendar as 26; but if the golden number does not exceed 11, that epact must correspond to the same day as 24. Hence the reason for distinguishing 25 and 25′. In using the calendar, if the epact of the year is 25, and the golden number not above 11, take 25; but if the golden number exceeds 11, take 25′.

Another peculiarity requires explanation. The epact 19′ (also distinguished by an accent or different character) is placed in the same line with 20 at the 31st of December. It is, however, only used in those years in which the epact 19 concurs with the golden number 19. When the golden number is 19, that is to say, in the last year of the lunar cycle, the supplementary month contains only 29 days. Hence, if in that year the epact should be 19, a new moon would fall on the 2nd of December, and the lunation would terminate on the 30th, so that the next new moon would arrive on the 31st. The epact of the year, therefore, or 19, must stand beside that day, whereas, according to the regular order, the epact corresponding to the 31st of December is 20; and this is the reason for the distinction.

As an example of the use of the preceding tables, suppose it were required to determine the moon's age on the 10th of April 1832. In 1832 the golden number is $\left(\frac{1832+1}{19}\right)_r = 9$, and the line of epacts belonging to the century is C. In Table III. under 9, and in the line C, we find the epact 28. In the calendar, Table IV. look for April, and the epact 28 is found opposite the second day. The 2nd of April is therefore the first day of the moon, and the 10th is consequently the ninth day of the moon.

Again, suppose it were required to find the moon's age on the 2nd of December in the year 1916. In this case the golden number is $\left(\frac{1916+1}{19}\right)_r = 17$, and in Table III., opposite to 1900, the line of epacts is B. Under 17, in line B, the epact is 25′. In the calendar this epact first occurs before the 2nd of December at the 26th of November. The 26th of November is consequently the first day of the moon, and the 2nd of December is therefore the seventh day.

Easter.—The next, and indeed the principal use of the calendar, is to find Easter, which, according to the regulation of the Council of Nice, must be determined from the following conditions:—*1st*, Easter must be celebrated on a Sunday; *2nd*, this Sunday must *follow* the 14th day of the paschal moon, so that if the 14th of the paschal moon falls on a Sunday, then Easter must be celebrated on the Sunday following; *3rd*, the paschal moon is that of which the 14th day falls on or next follows the day of the vernal equinox; *4th*, the equinox is fixed invariably in the calendar on the 21st of March. Sometimes a misunderstanding has arisen from not observing that this regulation is to be construed according to the tabular full moon as determined from the epact, and not by the true full moon, which, in general, occurs one or two days earlier.

From these conditions it follows that the paschal full moon, or the 14th of the paschal moon, cannot happen before the 21st of March, and that Easter in consequence cannot happen before the 22nd of March. If the 14th of the moon falls on the 21st, the new moon must fall on the 8th; for $21 - 13 = 8$; and the paschal new moon cannot happen before the 8th; for suppose the new moon to fall on the 7th, then the full moon would arrive on the 20th, or the day before the equinox. The following moon would be the paschal moon. But the fourteenth of this moon falls at the latest on the 18th of April, or 29 days after the 20th of March; for by reason of the double epact that occurs at the 4th and 5th of April, this lunation has only 29 days. Now, if in this case the 18th of April is Sunday, then Easter must be celebrated on the following Sunday, or the 25th of April. Hence Easter Sunday cannot happen earlier than the 22nd of March, or later than the 25th of April.

Hence we derive the following rule for finding Easter Sunday from the tables:—*1st*, Find the golden number, and, from Table III., the epact of the proposed year. *2nd*, Find in the calendar (Table IV.) the first day after the 7th of March which corresponds to the epact of the year; this will be the first day of the paschal moon. *3rd*, Reckon thirteen days after that of the first of the moon, the following will be the 14th of the moon, or the day of the full paschal moon. *4th*, Find from Table I. the dominical letter of the year, and observe in the calendar the first day, after the fourteenth of the moon, which corresponds to the dominical letter; this will be Easter Sunday.

Example.—Required the day on which Easter Sunday falls in the year 1840? *1st*, For this year the golden number is $\left(\frac{1840+1}{19}\right)_r = 17$, and the epact (Table III. line C) is 26. *2nd*, After the 7th of March the epact 26 first occurs in Table III. at the 4th of April, which, therefore, is the day of the new moon. *3rd*, Since the new moon falls on the 4th, the full moon is on the 17th ($4 + 13 = 17$). *4th*, The dominical letters of 1840 are E, D (Table I.), of which D must be taken, as E belongs only to January and February. After the 17th of April D first occurs in the calendar (Table IV.) at the 19th. Therefore, in 1840, Easter Sunday falls on the 19th of April. The operation is in all cases much facilitated by means of the following table:—

TABLE V.—*Perpetual Table, showing Easter.*

Epact.	Dominical Letter. *For Leap Years use the* SECOND *Letter.*						
	A	B	C	D	E	F	G
*	Apr. 16	Apr. 17	Apr. 18	Apr. 19	Apr. 20	Apr. 14	Apr. 15
1	,, 16	,, 17	,, 18	,, 19	,, 13	,, 14	,, 15
2	,, 16	,, 17	,, 18	,, 12	,, 13	,, 14	,, 15
3	,, 16	,, 17	,, 11	,, 12	,, 13	,, 14	,, 15
4	,, 16	,, 10	,, 11	,, 12	,, 13	,, 14	,, 15
5	,, 9	,, 10	,, 11	,, 12	,, 13	,, 14	,, 15
6	,, 9	,, 10	,, 11	,, 12	,, 13	,, 14	,, 8
7	,, 9	,, 10	,, 11	,, 12	,, 13	,, 7	,, 8
8	,, 9	,, 10	,, 11	,, 12	,, 6	,, 7	,, 8
9	,, 9	,, 10	,, 11	,, 5	,, 6	,, 7	,, 8
10	,, 9	,, 10	,, 4	,, 5	,, 6	,, 7	,, 8
11	,, 9	,, 3	,, 4	,, 5	,, 6	,, 7	,, 8
12	,, 2	,, 3	,, 4	,, 5	,, 6	,, 7	,, 8
13	,, 2	,, 3	,, 4	,, 5	,, 6	,, 7	,, 1
14	,, 2	,, 3	,, 4	,, 5	,, 6	Mar. 31	,, 1
15	,, 2	,, 3	,, 4	,, 5	Mar. 30	,, 31	,, 1
16	,, 2	,, 3	,, 4	Mar. 29	,, 30	,, 31	,, 1
17	,, 2	,, 3	Mar. 28	,, 29	,, 30	,, 31	,, 1
18	,, 2	Mar. 27	,, 28	,, 29	,, 30	,, 31	,, 1
19	Mar. 26	,, 27	,, 28	,, 29	,, 30	,, 31	,, 1
20	,, 26	,, 27	,, 28	,, 29	,, 30	,, 31	Mar. 25
21	,, 26	,, 27	,, 28	,, 29	,, 30	,, 24	,, 25
22	,, 26	,, 27	,, 28	,, 29	,, 23	,, 24	,, 25
23	,, 26	,, 27	,, 28	,, 22	,, 23	,, 24	,, 25
24	Apr. 23	Apr. 24	Apr. 25	Apr 19	Apr. 20	Apr. 21	Apr. 22
25	,, 23	,, 24	,, 25	,, 19	,, 20	,, 21	,, 22
26	,, 23	,, 24	,, 18	,, 19	,, 20	,, 21	,, 22
27	,, 23	,, 17	,, 18	,, 19	,, 20	,, 21	,, 22
28	,, 16	,, 17	,, 18	,, 19	,, 20	,, 21	,, 22
29	,, 16	,, 17	,, 18	,, 19	,, 20	,, 21	,, 15

Such is the very complicated and artificial, though highly ingenious method, invented by Lilius, for the determination of Easter and the other movable feasts. Its principal, though perhaps least obvious advantage, consists in its being entirely independent of astronomical tables, or indeed of any celestial phenomena whatever; so that all chances of disagreement arising from the inevitable errors of tables, or the uncertainty of observation, are avoided, and Easter determined without the possibility of mistake. But this advantage is only procured by the sacrifice of some accuracy; for notwithstanding the cumbersome apparatus employed, the conditions of the problem are not always exactly satisfied, nor is it possible that they can be always satisfied by any similar method of proceeding. The equinox is fixed on the 21st of March, though the sun enters Aries generally on the 20th of that month, sometimes even on the 19th. It is accordingly quite possible that a full moon may arrive after the true equinox, and yet precede the 21st of March. This, therefore, would not be the paschal moon of the calendar, though it undoubtedly ought to be so, if the intention of the Council of Nice were rigidly followed. The new moons indicated by the epacts also differ from the astronomical new moons, and even from the mean new moons, in general by one or two days. In imitation of the Jews, who counted the time of the new moon, not from the moment of the actual phase, but from the time the moon first became visible after the conjunction, the fourteenth day of the moon is regarded as the full moon; but the moon is in opposition generally on the 16th day; therefore, when the new moons of the calendar nearly concur with the true new moons, the full moons are considerably in error. The epacts are also placed so as to indicate the full moons generally one or two days after the true full moons; but this was done purposely, to avoid the chance of concurring with the Jewish passover, which the framers of the calendar seem to have considered a greater evil than that of celebrating Easter a week too late.

We will now show in what manner this whole apparatus of methods and tables may be dispensed with, and the Gregorian calendar reduced to a few simple formulæ of easy computation.

And, first, to find the dominical letter. Let L denote the number of the dominical letter of any given year of the era. Then, since every year which is not a leap year ends with the same day as that with which it began, the dominical letter of the

following year must be $L-1$, retrograding one letter every common year. After x years, therefore, the number of the letter will be $L-x$. But as L can never exceed 7, the number x will always exceed L after the first seven years of the era. In order therefore to render the subtraction possible, L must be increased by some multiple of 7, as $7m$, and the formula then becomes $7m+L-x$. In the year preceding the first of the era, the dominical letter was C; for that year, therefore, we have $L=3$; consequently for any succeeding year x, $L=7m+3-x$, the years being all supposed to consist of 365 days. But every fourth year is a leap year, and the effect of the intercalation is to throw the dominical letter one place farther back. The above expression must therefore be diminished by the number of units in $\frac{x}{4}$, or by $\left(\frac{x}{4}\right)_w$ (this notation being used to denote the quotient, *in a whole number*, that arises from dividing x by 4). Hence in the Julian calendar the dominical letter is given by the equation $L=7m+3-x-\left(\frac{x}{4}\right)_w$.

This equation gives the dominical letter of any year from the commencement of the era to the reformation. In order to adapt it to the Gregorian calendar, we must first add the 10 days that were left out of the year 1582; in the second place we must add one day for every century that has elapsed since 1600, in consequence of the secular suppression of the intercalary day; and lastly we must deduct the units contained in a fourth of the same number, because every fourth centesimal year is still a leap year. Denoting therefore the number of the century (or the date after the two right-hand digits have been struck out) by c, the value of L must be increased by $10+(c-16)-\left(\frac{c-16}{4}\right)_w$. We have then

$$L=7m+3-x-\left(\frac{x}{4}\right)_w+10+(c-16)-\left(\frac{c-16}{4}\right)_w;$$

that is, since $3+10=13$ or 6 (the 7 days being rejected, as they do not affect the value of L),

$$L=7m+6-x-\left(\frac{x}{4}\right)_w+(c-16)-\left(\frac{c-16}{4}\right)_w;$$

This formula is perfectly general, and easily calculated.

As an example, let us take the year 1839. In this case,

$$x=1839, \left(\frac{x}{4}\right)_w=\left(\frac{1839}{4}\right)_w=459, c=18, c-16=2,$$

and $\left(\frac{c-16}{4}\right)_w=0$. Hence

$$L=7m+6-1839-459+2-0$$
$$L=7m-2290=7\times 328-2290.$$
$$L=6=\text{letter F.}$$

The year therefore begins with Tuesday. It will be remembered that in a leap year there are always two dominical letters, one of which is employed till the 29th of February, and the other till the end of the year. In this case, as the formula supposes the intercalation already made, the resulting letter is that which applies after the 29th of February. Before the intercalation the dominical letter had retrograded one place less. Thus for 1840 the formula gives D; during the first two months, therefore, the dominical letter is E.

In order to investigate a formula for the epact, let us make

E = the true epact of the given year;

J = the Julian epact, that is to say, the number the epact would have been if the Julian year had been still in use and the lunar cycle had been exact;

S = the correction depending on the solar year;

M = the correction depending on the lunar cycle;

then the equation of the epact will be

$$E=J+S+M;$$

so that E will be known when the numbers J, S, and M are determined.

The epact J depends on the golden number N, and must be determined from the fact that in 1582, the first year of the reformed calendar, N was 6, and J 26. For the following years, then, the golden numbers and epacts are as follows:

$$\begin{aligned}
&1583,\ N=7, && J=26+11-30=7;\\
&1584,\ N=8, && J=7+11 \quad =18;\\
&1585,\ N=9, && J=18+11 \quad =29;\\
&1586,\ N=10, && J=29+11-30=10;
\end{aligned}$$

and, therefore, in general $J=\left(\frac{26+11(N-6)}{30}\right)_r$. But the numerator of this fraction becomes by reduction $11N-40$ or $11N-10$ (the 30 being rejected, as the remainder only is sought) $=N+10(N-1)$; therefore, ultimately,

$$J=\left(\frac{N+10(N-1)}{30}\right)_r$$

On account of the solar equation S, the epact J must be diminished by unity every centesimal year, excepting always the fourth. After x centuries, therefore, it must be diminished by $x-\left(\frac{x}{4}\right)_w$. Now, as 1600 was a leap year, the first correction of the Julian intercalation took place in 1700; hence, taking c to denote the number of the century as before, the correction becomes $(c-16)-\left(\frac{c-16}{4}\right)_w$, which must be deducted from J. We have therefore

$$S=-(c-16)+\left(\frac{c-16}{4}\right)_w.$$

With regard to the lunar equation M, we have already stated that in the Gregorian calendar the epacts are increased by unity at the end of every period of 300 years seven times successively, and then the increase takes place once at the end of 400 years. This gives eight to be added in a period of twenty-five centuries, and $\frac{8x}{25}$ in x centuries. But $\frac{8x}{25}=\frac{1}{3}\left(x-\frac{x}{25}\right)$. Now, from the manner in which the intercalation is directed to be made (namely, seven times successively at the end of 300 years, and once at the end of 400), it is evident that the fraction $\frac{x}{25}$ must amount to unity when the number of centuries amounts to twenty-four. In like manner, when the number of centuries is $24+25=49$, we must have $\frac{x}{25}=2$; when the number of centuries is $24+2\times 25=74$, then $\frac{x}{25}=3$; and, generally, when the number of centuries is $24+n\times 25$, then $\frac{x}{25}=n+1$. Now this is a condition which will evidently be expressed in general by the formula $n-\left(\frac{n+1}{25}\right)_w$. Hence the correction of the epact, or the number of days to be intercalated after x centuries reckoned from the commencement of one of the periods of twenty-five centuries, is $\left\{\frac{x-\left(\frac{x+1}{25}\right)_w}{3}\right\}_w$. The last period of twenty-five centuries terminated with 1800; therefore, in any succeeding year, if c be the number of the century, we shall have $x=c-18$ and $x+1=c-17$. Let $\left(\frac{c-17}{25}\right)_w=a$, then for all years after 1800 the value of M will be given by the formula $\left(\frac{c-18-a}{3}\right)_w$; therefore, counting from the beginning of the calendar in 1582,

$$M=\left\{\frac{c-15-a}{3}\right\}_w.$$

By the substitution of these values of J, S, and M, the equation of the epact becomes

$$E=\left(\frac{N+10(N-1)}{30}\right)_r-(c-16)+\left(\frac{c-16}{4}\right)_w+\left(\frac{c-15-a}{3}\right)_w.$$

It may be remarked, that as $a=\left(\frac{c-17}{25}\right)_w$, the value of a will be 0 till $c-17=25$ or $c=42$; therefore, till the year 4200, a may be neglected in the computation. Had the anticipation of the new moons been taken, as it ought to have been, at one day in 308 years instead of 312½, the lunar equation would have occurred only twelve times in 3700 years, or eleven times successively at the end of 300 years, and then at the end of 400. In strict accuracy, therefore, a ought to have no value till $c-17=37$, or $c=54$, that is to say, till the year 5400. The above formula for the epact is given by Delambre (*Hist. de l'Astronomie Moderne*, tom. i. p. 9); it may be exhibited under a variety of forms, but the above is perhaps the best adapted for calculation. Another had previously been given by Gauss, but inaccurately, inasmuch as the correction depending on a was omitted.

Having determined the epact of the year, it only remains to find Easter Sunday from the conditions already laid down. Let

P = the number of days from the 21st of March to the 15th of the paschal moon, which is the first day on which Easter Sunday can fall;

p = the number of days from the 21st of March to Easter Sunday.

L = the number of the dominical letter of the year;

l = letter belonging to the day on which the 15th of the moon falls then, since Easter is the Sunday following the 14th of the moon, we have

$$p=P+(L-l),$$

which is commonly called the *number of direction*.

The value of L is always given by the formula for the dominical letter, and P and l are easily deduced from the epact, as will appear from the following considerations.

When $P = 1$, the full moon is on the 21st of March, and the new moon on the eighth $(21 - 13 = 8)$, therefore the moon's age on the 1st of March (which is the same as on the 1st of January) is twenty-three days; the epact of the year is consequently twenty-three. When $P = 2$ the new moon falls on the ninth, and the epact is consequently twenty-two; and, in general, when P becomes $1 + x$, E becomes $23 - x$, therefore $P + E = 1 + x + 23 - x = 24$, and $P = 24 - E$. In like manner, when $P = 1$, $l = D = 4$; for D is the dominical letter of the calendar belonging to the 22nd of March. But it is evident that when l is increased by unity, that is to say, when the full moon falls a day later, the epact of the year is diminished by unity; therefore, in general, when $l = 4 + x$, $E = 23 - x$, whence $l + E = 27$ and $l = 27 - E$. But P can never be less than 1 nor l less than 4, and in both cases $E = 23$. When, therefore, E is greater than 23, we must add 30 in order that P and l may have positive values in the formula $P = 24 - E$ and $l = 27 - E$. Hence there are two cases.

$$\text{When} < 24, \quad \begin{cases} P = 24 - E \\ l = 27 - E, \text{ or } \left(\dfrac{27 - E}{7}\right)_r, \end{cases}$$

$$\text{When } E > 23, \quad \begin{cases} P = 54 - E \\ l = 57 - E, \text{ or } \left(\dfrac{57 - E}{7}\right)_r \end{cases}$$

By substituting one or other of these values of P and l, according as the case may be, in the formula $p = P + (L - l)$, we shall have p, or the number of days from the 21st of March to Easter Sunday. It will be remarked, that as $L - l$ cannot either be 0 or negative, we must add 7 to L as often as may be necessary, in order that $L - l$ may be a positive whole number.

By means of the formulæ which we have now given for the dominical letter, the golden number, and the epact, Easter Sunday may be computed for any year after the reformation, without the assistance of any tables whatever. As an example, suppose it were required to compute Easter for the year 1840. By substituting this number in the formula for the dominical letter, we have $x = 1840$,

$c - 16 = 2$, $\left(\dfrac{c-16}{4}\right)_w = 0$, therefore

$$\begin{aligned} L &= 7m + 6 - 1840 - 460 + 2 \\ &= 7m - 2292 \\ &= 7 \times 328 - 2292 = 2296 - 2292 = 4 \\ L &= 4 = \text{letter D} \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1). \end{aligned}$$

For the golden number we have $N = \left(\dfrac{1840 + 1}{19}\right)_r$;

therefore $N = 17$ ……………………………………(2).

For the epact we have $\left(\dfrac{N + 10(N-1)}{30}\right)_r = \left(\dfrac{17 + 160}{30}\right)_r = \left(\dfrac{177}{30}\right)_r$

$= 27$; likewise $c - 16 = 18 - 16 = 2$, $\dfrac{c-15}{3} = 1$, $a = 0$; therefore

$$E = 27 - 2 + 1 = 26 \ldots\ldots\ldots\ldots\ldots\ldots\ldots(3).$$

Now since $E > 23$, we have for P and l,

$$P = 54 - E = 54 - 26 = 28,$$

$$l = \left(\frac{57 - E}{7}\right)_r = \left(\frac{57 - 26}{7}\right)_r = \left(\frac{31}{7}\right)_r = 3;$$

consequently, since $p = P + (L - l)$,

$$p = 28 + (4 - 3) = 29;$$

that is to say, Easter happens twenty-nine days after the 21st of March, or on the 19th April, the same result as was before found from the tables.

The principal church feasts depending on Easter, and the times of their celebration, are as follows:—

Septuagesima Sunday	is	9 weeks	before Easter.
First Sunday in Lent		6 weeks	
Ash Wednesday		46 days	
Rogation Sunday	is	5 weeks	after Easter.
Ascension day or Holy Thursday		39 days	
Pentecost or Whitsunday		7 weeks	
Trinity Sunday		8 weeks	

The Gregorian calendar was introduced into Spain, Portugal, and part of Italy, the same day as at Rome. In France it was received in the same year in the month of December, and by the Catholic states of Germany the year following. In the Protestant states of Germany the Julian calendar was adhered to till the year 1700, when it was decreed by the diet of Ratisbon that the new style and the Gregorian correction of the intercalation should be adopted. Instead, however, of employing the golden numbers and epacts for the determination of Easter and the movable feasts, it was resolved that the equinox and the paschal moon should be found by astronomical computation from the Rudolphine tables. But this method, though at first view it may appear more accurate, was soon found to be attended with numerous inconveniences, and was at length, in 1774, abandoned at the instance of Frederick II. king of Prussia. In Denmark and Sweden the reformed calendar was received about the same time as in the Protestant states of Germany. It is remarkable that Russia still adheres to the Julian reckoning.

In Great Britain the alteration of the style was for a long time successfully opposed by popular prejudice. The inconvenience, however, of using a different date from that employed by the greater part of Europe, in matters of history and chronology, began to be generally felt; and at length, in 1751, an Act of Parliament was passed for the adoption of the new style in all public and legal transactions. The difference of the two styles, which then amounted to eleven days, was removed by ordering the day following the 2d of September of the year 1752 to be accounted the 14th of that month; and in order to preserve uniformity in future, the Gregorian rule of intercalation respecting the secular years was adopted. At the same time, the commencement of the legal year was changed from the 25th of May to the 1st of January. In Scotland, the new style was adopted from the beginning of 1600, according to an Act of the privy council in December 1599. This fact is of importance with reference to the date of legal deeds executed in Scotland between that period and 1751, when the change was effected in England. With respect to the movable feasts, Easter is determined by the rule laid down by the Council of Nice; but instead of employing the new moons and epacts, the golden numbers are prefixed to the days of the *full* moons. In those years in which the line of epacts is changed in the Gregorian calendar, the golden numbers are removed to different days, and of course a new table is required whenever the solar or lunar equation occurs. The golden numbers have been placed so that Easter may fall on the same day as in the Gregorian calendar. The calendar of the church of England is therefore from century to century the same in form as the old Roman calendar, excepting that the golden numbers indicate the full moons instead of the new moons.

Hebrew Calendar.—In the construction of the Jewish calendar numerous details require attention. The calendar is dated from the Creation, which is considered to have taken place 3760 years and 3 months before the commencement of the Christian era. The year is luni-solar, and, according as it is ordinary or embolismic, consists of twelve or thirteen lunar months, each of which has 29 or 30 days. Thus the duration of the ordinary year is 354 days, and that of the embolismic is 384 days. In either case, it is sometimes made a day more, and sometimes a day less, in order that certain festivals may fall on proper days of the week for their due observance. The distribution of the embolismic years, in each cycle of 19 years, is determined according to the following rule:—

The number of the Hebrew year (Y) which has its commencement in a Gregorian year (x) is obtained by the addition of 3761 years; that is, $Y = x + 3761$. Divide the Hebrew year by 19; then the quotient is the number of the last completed cycle, and the remainder is the year of the current cycle. If the remainder be 3, 6, 8, 11, 14, 17, or 19 (0), the year is embolismic; if any other number, it is ordinary. Or, otherwise, if we find the remainder

$$R = \left(\frac{7Y + 1}{19}\right)_r$$

the year is embolismic when $R < 7$.

The calendar is constructed on the assumptions that the mean lunation is 29 days 12 hours 44 min. $3\frac{1}{3}$ sec., and that the year commences on, or immediately after, the new moon following the autumnal equinox. The mean solar year is also assumed to be 365 days 5 hours 55 min. $25\frac{25}{57}$ sec., so that a cycle of nineteen of such years, containing 6939 days 16 hours 33 min. $3\frac{1}{3}$ sec., is the exact measure of 235 of the assumed lunations. The year 5606 was the first of a cycle, and the mean new moon, appertaining to the 1st of Tisri for that year, was 1845, October 1, 15 hours 42 min. $43\frac{1}{3}$ sec., as computed by Lindo, and adopting the civil mode of reckoning from the previous midnight. The times of all future new moons may consequently be deduced by successively adding 29 days 12 hours 44 min. $3\frac{1}{3}$ sec. to this date.

To compute the times of the new moons which determine the commencement of successive years, it must be observed that in passing from an ordinary year the new moon of the following year is deduced by subtracting the interval that twelve lunations fall short of the corresponding Gregorian year of 365 or 366 days; and that, in passing from an embolismic year, it is to be found by adding the excess of thirteen lunations over the Gregorian year. Thus to deduce the new moon of Tisri, for the year immediately following any given year (Y), when Y is

$$\begin{cases} \text{ordinary, subtract } \binom{10}{11} \text{ days 15 hours 11 min. 20 sec.,} \\ \text{embolismic, add } \binom{18}{17} \text{ days 21 hours 32 min. } 43\tfrac{1}{3} \text{ sec.,} \end{cases}$$

the second-mentioned number of days being used, in each case, whenever the following or new Gregorian year is bissextile.

Hence, knowing which of the years are embolismic, from their ordinal position in the cycle, according to the rule before stated, the times of the commencement of successive years may be thus carried on indefinitely without any difficulty. But some slight adjustments will occasionally be needed for the reasons before assigned, viz., to avoid certain festivals falling on incompatible days of the week. Whenever the computed conjunction falls on a Sunday, Wednesday, or Friday, the new year is in such case to be fixed on the day after. It will also be requisite to attend to the following conditions:—

If the computed new moon be after 18 hours, the following day is to be taken, and if that happen to be Sunday, Wednesday, or Friday, it must be further postponed one day. If, for an ordinary year, the new moon falls on a Tuesday, as late as 9 hours 11 min. 20 sec., it is not to be observed thereon; and as it may not be held on a Wednesday, it is in such case to be postponed to Thursday. If, for a year immediately following an embolismic year, the computed new moon is on Monday, as late as 15 hours 30 min. 52 sec., the new year is to be fixed on Tuesday.

After the dates of commencement of the successive Hebrew years are finally adjusted, conformably with the foregoing directions, an estimation of the consecutive intervals, by taking the differences, will show the duration and character of the years that respectively intervene. According to the number of days thus found to be comprised in the different years, the days of the several months are distributed as in Table VI.

The signs + and − are respectively annexed to Hesvan and Kislev to indicate that the former of these months may sometimes require to have one day more, and the latter sometimes one day less, than the number of days shown in the table,—the result, in every case, being at once determined by the total number of days that the year may happen to contain. An ordinary year may comprise 353, 354, or 355 days; and an embolismic year 383, 384, or 385 days. In these cases respectively the year is said to be imperfect, common, or perfect. The intercalary month, Veadar, is introduced in embolismic years in order that Passover, the 15th day of Nisan, may be kept at its proper season, which is the full moon of the vernal equinox, or that which takes place after the sun has entered the sign Aries. It always precedes the following new year by 163 days, or 23 weeks and 2 days; and Pentecost always precedes the new year by 113 days, or 16 weeks and 1 day.

TABLE VI.—*Hebrew Months.*

Hebrew Month	Ordinary Year	Embolismic Year
Tisri	30	30
Hesvan	29+	29+
Kislev	30−	30−
Tebet	29	29
Sebat	30	30
Adar	29	30
(Veadar)	(...)	(29)
Nisan	30	30
Yiar	29	29
Sivan	30	30
Tamuz	29	29
Ab	30	30
Elul	29	29
Total	354	384

The Gregorian epact being the age of the moon of Tebet at the beginning of the Gregorian year, it represents the day of Tebet which corresponds to January 1; and thus the approximate date of Tisri 1, the commencement of the Hebrew year, may be otherwise deduced by subtracting the epact from

$$\left.\begin{matrix}\text{Sept. 24}\\ \text{Oct. 24}\end{matrix}\right\} \text{after an} \left\{\begin{matrix}\text{ordinary}\\ \text{embolismic}\end{matrix}\right\} \text{Hebrew year.}$$

The result so obtained would in general be more accurate than the Jewish calculation, from which it may differ a day, as fractions of a day do not enter alike in these computations. Such difference may also in part be accounted for by the fact that the assumed duration of the solar year is 6 min. $39\frac{25}{57}$ sec. in excess of the true astronomical value, which will cause the dates of commencement of future Jewish years, so calculated, to advance forward from the equinox a day in error in 216 years. The lunations are estimated with much greater precision.

The following table is extracted from Woolhouse's *Measures, Weights, and Moneys of all Nations*:—

TABLE VII.—*Hebrew Years.*

	Jewish Year.	Number of Days.	Commencement (1st of Tisri).			Jewish Year.	Number of Days.	Commencement (1st of Tisri).	
296 Cycle.	5606	354	Thur.	2 Oct. 1845	297 Cycle.	5625	355	Sat.	1 Oct. 1864
	07	355	Mon.	21 Sept. 1846		26	354	Thur.	21 Sept. 1865
	08	383	Sat.	11 Sept. 1847		27	385	Mon.	10 Sept. 1866
	09	354	Thur.	28 Sept. 1848		28	353	Mon.	30 Sept. 1867
	10	355	Mon.	17 Sept. 1849		29	354	Thur.	17 Sept. 1868
	11	385	Sat.	7 Sept. 1850		30	385	Mon.	6 Sept. 1869
	12	353	Sat.	27 Sept. 1851		31	355	Mon.	26 Sept. 1870
	13	384	Tues.	14 Sept. 1852		32	383	Sat.	16 Sept. 1871
	14	355	Mon.	3 Oct. 1853		33	354	Thur.	3 Oct. 1872
	15	355	Sat.	23 Sept. 1854		34	355	Mon.	22 Sept. 1873
	16	383	Thur.	13 Sept. 1855		35	383	Sat.	12 Sept. 1874
	17	354	Tues.	30 Sept. 1856		36	355	Thur.	30 Sept. 1875
	18	355	Sat.	19 Sept. 1857		37	354	Tues.	19 Sept. 1876
	19	385	Thur.	9 Sept. 1858		38	385	Sat.	8 Sept. 1877
	20	354	Thur.	29 Sept. 1859		39	355	Sat.	28 Sept. 1878
	21	353	Mon.	17 Sept. 1860		40	354	Thur.	18 Sept. 1879
	22	385	Thur.	5 Sept. 1861		41	383	Mon.	6 Sept. 1880
	23	354	Thur.	25 Sept. 1862		42	355	Sat.	24 Sept. 1881
	24	383	Mon.	14 Sept. 1863		43	383	Thur.	14 Sept. 1882

TABLE VII.—*Hebrew Years (continued).*

Cycle	Jewish Year.	Number of Days.	Commencement (1st of Tisri).		Cycle	Jewish Year.	Number of Days.	Commencement (1st of Tisri).	
298 Cycle.	5644	354	Tues.	2 Oct. 1883	302 Cycle.	5720	355	Sat.	3 Oct. 1959
	45	355	Sat.	20 Sept. 1884		21	354	Thur.	22 Sept. 1960
	46	385	Thur.	10 Sept. 1885		22	383	Mon.	11 Sept. 1961
	47	354	Thur.	30 Sept. 1886		23	355	Sat.	29 Sept. 1962
	48	353	Mon.	19 Sept. 1887		24	354	Thur.	19 Sept. 1963
	49	385	Thur.	6 Sept. 1888		25	385	Mon.	7 Sept. 1964
	50	354	Thur.	26 Sept. 1889		26	353	Mon.	27 Sept. 1965
	51	383	Mon.	15 Sept. 1890		27	385	Thur.	15 Sept. 1966
	52	355	Sat.	3 Oct. 1891		28	354	Thur.	5 Oct. 1967
	53	354	Thur.	22 Sept. 1892		29	355	Mon.	23 Sept. 1968
	54	385	Mon.	11 Sept. 1893		30	383	Sat.	13 Sept. 1969
	55	353	Mon.	1 Oct. 1894		31	354	Thur.	1 Oct. 1970
	56	355	Thur.	19 Sept. 1895		32	355	Mon.	20 Sept. 1971
	57	384	Tues.	8 Sept. 1896		33	383	Sat.	9 Sept. 1972
	58	355	Mon.	27 Sept. 1897		34	355	Thur.	27 Sept. 1973
	59	353	Sat.	17 Sept. 1898		35	354	Tues.	17 Sept. 1974
	60	384	Tues.	5 Sept. 1899		36	385	Sat.	6 Sept. 1975
	61	355	Mon.	24 Sept. 1900		37	353	Sat.	25 Sept. 1976
	62	383	Sat.	14 Sept. 1901		38	384	Tues.	13 Sept. 1977
299 Cycle.	5663	355	Thur.	2 Oct. 1902	303 Cycle.	5739	355	Mon.	2 Oct. 1978
	64	354	Tues.	22 Sept. 1903		40	355	Sat.	22 Sept. 1979
	65	385	Sat.	10 Sept. 1904		41	383	Thur.	11 Sept. 1980
	66	355	Sat.	30 Sept. 1905		42	354	Tues.	29 Sept. 1981
	67	354	Thur.	20 Sept. 1906		43	355	Sat.	18 Sept. 1982
	68	383	Mon.	9 Sept. 1907		44	385	Thur.	8 Sept. 1983
	69	355	Sat.	26 Sept. 1908		45	354	Thur.	27 Sept. 1984
	70	383	Thur.	16 Sept. 1909		46	383	Mon.	16 Sept. 1985
	71	354	Tues.	4 Oct. 1910		47	355	Sat.	4 Oct. 1986
	72	355	Sat.	23 Sept. 1911		48	354	Thur.	24 Sept. 1987
	73	385	Thur.	12 Sept. 1912		49	383	Mon.	12 Sept. 1988
	74	354	Thur.	2 Oct. 1913		50	355	Sat.	30 Sept. 1989
	75	353	Mon.	21 Sept. 1914		51	354	Thur.	20 Sept. 1990
	76	385	Thur.	9 Sept. 1915		52	385	Mon.	9 Sept. 1991
	77	354	Thur.	28 Sept. 1916		53	353	Mon.	28 Sept. 1992
	78	355	Mon.	17 Sept. 1917		54	355	Thur.	16 Sept. 1993
	79	383	Sat.	7 Sept. 1918		55	384	Tues.	6 Sept. 1994
	80	354	Thur.	25 Sept. 1919		56	355	Mon.	25 Sept. 1995
	81	385	Mon.	13 Sept. 1920		57	383	Sat.	14 Sept. 1996
300 Cycle.	5682	355	Mon.	3 Oct. 1921	304 Cycle.	5758	354	Thur.	2 Oct. 1997
	83	353	Sat.	23 Sept. 1922		59	355	Mon.	21 Sept. 1998
	84	384	Tues.	11 Sept. 1923		60	385	Sat.	11 Sept. 1999
	85	355	Mon.	29 Sept. 1924		61	353	Sat.	30 Sept. 2000
	86	355	Sat.	19 Sept. 1925		62	354	Tues.	18 Sept. 2001
	87	383	Thur.	9 Sept. 1926		63	385	Sat.	7 Sept. 2002
	88	354	Tues.	27 Sept. 1927		64	355	Sat.	27 Sept. 2003
	89	385	Sat.	15 Sept. 1928		65	383	Thur.	16 Sept. 2004
	90	353	Sat.	5 Oct. 1929		66	354	Tues.	4 Oct. 2005
	91	354	Tues.	23 Sept. 1930		67	355	Sat.	23 Sept. 2006
	92	385	Sat.	12 Sept. 1931		68	383	Thur.	13 Sept. 2007
	93	355	Sat.	1 Oct. 1932		69	354	Tues.	30 Sept. 2008
	94	354	Thur.	21 Sept. 1933		70	355	Sat.	19 Sept. 2009
	95	383	Mon.	10 Sept. 1934		71	385	Thur.	9 Sept. 2010
	96	355	Sat.	28 Sept. 1935		72	354	Thur.	29 Sept. 2011
	97	354	Thur.	17 Sept. 1936		73	353	Mon.	17 Sept. 2012
	98	385	Mon.	6 Sept. 1937		74	385	Thur.	5 Sept. 2013
	99	353	Mon.	26 Sept. 1938		75	354	Thur.	25 Sept. 2014
	5700	385	Thur.	14 Sept. 1939		76	385	Mon.	14 Sept. 2015
301 Cycle.	5701	354	Thur.	3 Oct. 1940	305 Cycle.	5777	353	Mon.	3 Oct. 2016
	02	355	Mon.	22 Sept. 1941		78	354	Thur.	21 Sept. 2017
	03	383	Sat.	12 Sept. 1942		79	385	Mon.	10 Sept. 2018
	04	354	Thur.	30 Sept. 1943		80	355	Mon.	30 Sept. 2019
	05	355	Mon.	18 Sept. 1944		81	353	Sat.	19 Sept. 2020
	06	383	Sat.	8 Sept. 1945		82	384	Tues.	7 Sept. 2021
	07	354	Thur.	26 Sept. 1946		83	355	Mon.	26 Sept. 2022
	08	385	Mon.	15 Sept. 1947		84	383	Sat.	16 Sept. 2023
	09	355	Mon.	4 Oct. 1948		85	355	Thur.	3 Oct. 2024
	10	353	Sat.	24 Sept. 1949		86	354	Tues.	23 Sept. 2025
	11	384	Tues.	12 Sept. 1950		87	385	Sat.	12 Sept. 2026
	12	355	Mon.	1 Oct. 1951		88	355	Sat.	2 Oct. 2027
	13	355	Sat.	20 Sept. 1952		89	354	Thur.	21 Sept. 2028
	14	383	Thur.	10 Sept. 1953		90	383	Mon.	10 Sept. 2029
	15	354	Tues.	28 Sept. 1954		91	355	Sat.	28 Sept. 2030
	16	355	Sat.	17 Sept. 1955		92	354	Thur.	18 Sept. 2031
	17	385	Thur.	6 Sept. 1956		93	383	Mon.	6 Sept. 2032
	18	354	Thur.	26 Sept. 1957		94	355	Sat.	24 Sept. 2033
	19	383	Mon.	15 Sept. 1958		95	385	Thur.	14 Sept. 2034

TABLE VII.—*Hebrew Years (continued).*

Cycle	Jewish Year.	Number of Days.	Commencement (1st of Tisri).		Cycle	Jewish Year.	Number of Days.	Commencement (1st of Tisri).	
306 Cycle.	5796	354	Thur.	4 Oct. 2035	307 Cycle.	5815	355	Sat.	3 Oct. 2054
	97	353	Mon.	22 Sept. 2036		16	354	Thur.	23 Sept. 2055
	98	385	Thur.	10 Sept. 2037		17	383	Mon.	11 Sept. 2056
	99	354	Thur.	30 Sept. 2038		18	355	Sat.	29 Sept. 2057
	5800	355	Mon.	19 Sept. 2039		19	354	Thur.	19 Sept. 2058
	01	383	Sat.	8 Sept. 2040		20	383	Mon.	8 Sept. 2059
	02	354	Thur.	26 Sept. 2041		21	355	Sat.	25 Sept. 2060
	03	385	Mon.	15 Sept. 2042		22	385	Thur.	15 Sept. 2061
	04	353	Mon.	5 Oct. 2043		23	354	Thur.	5 Oct. 2062
	05	355	Thur.	22 Sept. 2044		24	353	Mon.	24 Sept. 2063
	06	384	Tues.	12 Sept. 2045		25	385	Thur.	11 Sept. 2064
	07	355	Mon.	1 Oct. 2046		26	354	Thur.	1 Oct. 2065
	08	353	Sat.	21 Sept. 2047		27	355	Mon.	20 Sept. 2066
	09	384	Tues.	8 Sept. 2048		28	383	Sat.	10 Sept. 2067
	10	355	Mon.	27 Sept. 2049		29	354	Thur.	27 Sept. 2068
	11	355	Sat.	17 Sept. 2050		30	355	Mon.	16 Sept. 2069
	12	383	Thur.	7 Sept. 2051		31	383	Sat.	6 Sept. 2070
	13	354	Tues.	24 Sept. 2052		32	355	Thur.	24 Sept. 2071
	14	385	Sat.	13 Sept. 2053		33	384	Tues.	13 Sept. 2072

MAHOMETAN CALENDAR.—The Mahometan era, or era of the Hegira, employed in Turkey, Persia, Arabia, &c., is dated from the flight of Mahomet from Mecca to Medina, which was in the night of Thursday the 15th of July 622 A.D., and it commenced on the day following. The years of the Hegira are purely lunar, and always consist of twelve lunar months, commencing with the approximate new moon, without any intercalation to keep them to the same season with respect to the sun, so that they retrograde through all the seasons in about $32\frac{1}{2}$ years. They are also partitioned into cycles of 30 years, 19 of which are common years of 354 days each, and the other 11 are intercalary years having an additional day appended to the last month. The mean length of the year is therefore $354\frac{11}{30}$ days, or 354 days 8 hours 48 min., which divided by 12 gives $29\frac{191}{360}$ days, or 29 days 12 hours 44 min., as the time of a mean lunation, and this differs from the astronomical mean lunation by only 2·8 seconds. This small error will only amount to a day in about 2400 years.

To find if a year is intercalary or common, divide it by 30; the quotient will be the number of completed cycles and the remainder will be the year of the current cycle; if this last be one of the numbers 2, 5, 7, 10, 13, 16, 18, 21, 24, 26, 29, the year is intercalary and consists of 355 days; if it be any other number, the year is ordinary.

Or if Y denote the number of the Mahometan year, and

$$R=\left(\frac{11\,Y+14}{30}\right)_r,$$

the year is intercalary when $R<11$.

Also the number of intercalary years from the year 1 up to the year Y inclusive $=\left(\frac{11\,Y+14}{30}\right)_w$; and the same up to the year $Y-1=\left(\frac{11\,Y+3}{30}\right)_w$.

To find the day of the week on which any year of the Hegira begins, we observe that the year 1 began on a Friday, and that after every common year of 354 days, or 50 weeks and 4 days, the day of the week must necessarily become postponed 4 days, besides the additional day of each intercalary year.

Hence if $w=1$ indicate Sun.	2 Mon.	3 Tues.	4 Wed.	5 Thur.	6 Frid.	7 Sat.

the day of the week on which the year Y commences will be

$$w=2+4\left(\frac{Y}{7}\right)_r+\left(\frac{11\,Y+3}{30}\right)_w \text{ (rejecting sevens)}$$

$$\text{But, } 30\left(\frac{11\,Y+3}{30}\right)_w+\left(\frac{11\,Y+3}{30}\right)_r=11\,Y+3$$

$$\text{gives } 120\left(\frac{11\,Y+3}{30}\right)_w=12+44\,Y-4\left(\frac{11\,Y+3}{30}\right)_r,$$

$$\text{or } \left(\frac{11\,Y+3}{30}\right)_w=5+2\,Y+8\left(\frac{11\,Y+3}{30}\right)_r \text{ (rejecting sevens).}$$

So that

$$w = 6\left(\frac{Y}{7}\right)_r + 3\left(\frac{11\,Y + 3}{30}\right)_r \text{ (rejecting sevens),}$$

the values of which obviously circulate in a period of 7 times 30 or 210 years.

Let C denote the number of completed cycles, and y the year of the cycle; then $Y = 30\,C + y$, and

$$w = 5\left(\frac{C}{7}\right)_r + 6\left(\frac{y}{7}\right)_r + 3\left(\frac{11\,y + 3}{30}\right)_r \text{ (rejecting sevens).}$$

From this formula the following table has been constructed:—

TABLE VIII.

Year of the Current Cycle (y.)				Number of the Period of Seven Cycles $= \left(\frac{C}{7}\right)_r$						
				0	1	2	3	4	5	6
0	8			Mon.	Sat.	Thur.	Tues.	Sun.	Frid.	Wed.
1	9	17	25	Frid.	Wed.	Mon.	Sat.	Thur.	Tues.	Sun.
*2	*10	*18	*26	Tues.	Sun.	Frid.	Wed.	Mon.	Sat.	Thur.
3	11	19	27	Sun.	Frid.	Wed.	Mon.	Sat.	Thur.	Tues.
4	12	20	28	Thur.	Tues.	Sun.	Frid.	Wed.	Mon.	Sat.
*5	*13	*21	*29	Mon.	Sat	Thur.	Tues.	Sun.	Frid.	Wed.
6	14	22	30	Sat.	Thur.	Tues.	Sun.	Frid.	Wed.	Mon.
*7	15	23		Wed.	Mon.	Sat.	Thur.	Tues.	Sun.	Frid.
	*16	*24		Sun.	Frid.	Wed.	Mon.	Sat.	Thur.	Tues.

To find from this table the day of the week on which any year of the Hegira commences, the rule to be observed will be as follows:—

Rule.—Divide the year of the Hegira by 30; the quotient is the number of cycles, and the remainder is the year of the current cycle. Next divide the number of cycles by 7, and the second remainder will be the Number of the Period, which being found at the top of the table, and the year of the cycle on the left hand, the required day of the week is immediately shown.

The intercalary years of the cycle are distinguished by an asterisk.

For the computation of the Christian date, the ratio of a mean year of the Hegira to a solar year is

$$\frac{\text{Year of Hegira}}{\text{Mean solar year}} = \frac{354\frac{11}{30}}{365\cdot2422} = 0\cdot970224.$$

The year 1 began 16 July 622, Old Style, or 19 July 622, according to the New or Gregorian Style. Now the day of the year answering to the 19th of July is 200, which, in parts of the solar year, is 0·5476, and the number of years elapsed $= Y - 1$. Therefore, as the intercalary days are distributed with considerable regularity in both calendars, the date of commencement of the year Y expressed in Gregorian years is

$$0\cdot970224\,(Y - 1) + 622\cdot5476,$$
$$\text{or } 0\cdot970224\,Y + 621\cdot5774.$$

This formula gives the following rule for calculating the date of the commencement of any year of the Hegira, according to the Gregorian or New Style.

Rule.—Multiply 970224 by the year of the Hegira, cut off six decimals from the product, and add 621·5774. The sum will be the year of the Christian era, and the day of the year will be found by multiplying the decimal figures by 365.

The result may sometimes differ a day from the truth, as the intercalary days do not occur simultaneously; but as the day of the week can always be accurately obtained from the foregoing table, the result can be readily adjusted.

Example.—Required the date on which the year 1362 of the Hegira begins.

$$\begin{array}{r}
970224 \\
1362 \\
\hline
1940448 \\
5821344 \\
2910672 \\
970224 \\
\hline
1321\cdot445088 \\
621\cdot5774 \\
\hline
1943\cdot0225 \\
365 \\
\hline
1125 \\
1350 \\
675 \\
\hline
8\cdot2125
\end{array}$$

Thus the date is the 8th day, or the 8th of January, of the year 1943.

To find, as a test, the accurate day of the week, the proposed year of the Hegira, divided by 30, gives 45 cycles, and remainder 12, the year of the current cycle.

Also 45, divided by 7, leaves a remainder 3 for the number of the period.

Therefore, referring to 3 at the top of the table, and 12 on the left, the required day is Friday.

The tables, page 670, show that 8th January 1943 is a Friday, therefore the date is exact.

For any other date of the Mahometan year it is only requisite to know the names of the consecutive months, and the number of days in each; these are—

Muharram, ...	30	Shaaban, ...	29
Saphar, ...	29	Ramadân, ...	30
Rabia I., ...	30	Shawall, ...	29
Rabia II., ...	29	Dulkaada, ...	30
Jomada I., ...	30	Dulheggia, ...	29
Jomada II., ...	29	and in intercalary years	30
Rajab, ...	30		

The ninth month, Ramadân, is the month of Abstinence observed by the Turks.

The Turkish calendar may evidently be carried on indefinitely by successive addition, observing only to allow for the additional day that occurs in the bissextile and intercalary years; but for any remote date the computation according to the preceding rules will be most efficient, and such computation may be usefully employed as a check on the accuracy of any considerable extension of the calendar by induction alone.

The following table, taken from Woolhouse's *Measures, Weights, and Moneys of all Nations,* shows the dates of commencement of Mahometan years from 1845 up to 2047, or from the 43rd to the 49th cycle inclusive, which form the whole of the seventh period of seven cycles. Throughout the next period of seven cycles, and all other like periods, the days of the week will recur in exactly the same order. All the tables of this kind previously published, which extend beyond the year 1900 of the Christian era, are erroneous, not excepting the celebrated French work, *L'Art de vérifier les Dates*, so justly regarded as the greatest authority in chronological matters. The errors have probably arisen from a continued excess of 10 in the discrimination of the intercalary years.

TABLE IX.—*Mahometan Years.*

43d Cycle.				43d Cycle—*continued.*			
Year of Hegira.	Commencement (1st of Muharram).			Year of Hegira.	Commencement (1st of Muharram).		
1261	Frid.	10 Jan.	1845	1286*	Tues.	13 April	1869
1262*	Tues.	30 Dec.	1845	1287	Sun.	3 April	1870
1263	Sun.	20 Dec.	1846	1288	Thur.	23 Mar.	1871
1264	Thur.	9 Dec.	1847	1289*	Mon.	11 Mar.	1872
1265*	Mon.	27 Nov.	1848	1290	Sat.	1 Mar.	1873
1266	Sat.	17 Nov.	1849				
1267*	Wed.	6 Nov.	1850	44th Cycle.			
1268	Mon.	27 Oct.	1851				
1269	Frid.	15 Oct.	1852	1291	Wed.	18 Feb.	1874
1270*	Tues.	4 Oct.	1853	1292*	Sun.	7 Feb.	1875
1271	Sun.	24 Sept.	1854	1293	Frid.	28 Jan.	1876
1272	Thur.	13 Sept.	1855	1294	Tues.	16 Jan.	1877
1273*	Mon.	1 Sept.	1856	1295*	Sat.	5 Jan.	1878
1274	Sat.	22 Aug.	1857	1296	Thur.	26 Dec.	1878
1275	Wed.	11 Aug.	1858	1297*	Mon.	15 Dec.	1879
1276*	Sun.	31 July	1859	1298	Sat.	4 Dec.	1880
1277	Frid.	20 July	1860	1299	Wed.	23 Nov.	1881
1278*	Tues.	9 July	1861	1300*	Sun.	12 Nov.	1882
1279	Sun.	29 June	1862	1301	Frid.	2 Nov.	1883
1280	Thur.	18 June	1863	1302	Tues.	21 Oct.	1884
1281*	Mon.	6 June	1864	1303*	Sat.	10 Oct.	1885
1282	Sat.	27 May	1865	1304	Thur.	30 Sept.	1886
1283	Wed.	16 May	1866	1305	Mon.	19 Sept.	1887
1284*	Sun.	5 May	1867	1306*	Frid.	7 Sept.	1888
1285	Frid.	24 April	1868	1307	Wed.	28 Aug.	1889

44th Cycle—*continued.*

Year of Hegira.	Commencement (1st of Muharram).		
1308*	Sun.	17 Aug.	1890
1309	Frid.	7 Aug.	1891
1310	Tues	26 July	1892
1311*	Sat.	15 July	1893
1312	Thur.	5 July	1894
1313	Mon.	24 June	1895
1314*	Frid.	12 June	1896
1315	Wed.	2 June	1897
1316*	Sun.	22 May	1898
1317	Frid.	12 May	1899
1318	Tues.	1 May	1900
1319*	Sat.	20 April	1901
1320	Thur.	10 April	1902

45th Cycle.

Year of Hegira.	Commencement (1st of Muharram).		
1321	Mon.	30 Mar.	1903
1322*	Frid.	18 Mar.	1904
1323	Wed.	8 Mar.	1905
1324	Sun.	25 Feb.	1906
1325*	Thur.	14 Feb.	1907
1326	Tues.	4 Feb.	1908
1327*	Sat.	23 Jan.	1909
1328	Thur.	13 Jan.	1910
1329	Mon.	2 Jan.	1911
1330*	Frid.	22 Dec.	1911
1331	Wed.	11 Dec.	1912
1332	Sun.	30 Nov.	1913
1333*	Thur.	19 Nov.	1914
1334	Tues.	9 Nov.	1915
1335	Sat.	28 Oct.	1916
1336*	Wed.	17 Oct.	1917
1337	Mon.	7 Oct.	1918
1338*	Frid.	26 Sept.	1919
1339	Wed.	15 Sept.	1920
1340	Sun.	4 Sept.	1921
1341*	Thur.	24 Aug.	1922
1342	Tues.	14 Aug.	1923
1343	Sat.	2 Aug.	1924
1344*	Wed.	22 July	1925
1345	Mon.	12 July	1926
1346*	Frid.	1 July	1927
1347	Wed.	20 June	1928
1348	Sun.	9 June	1929
1349*	Thur.	29 May	1930
1350	Tues.	19 May	1931

46th Cycle.

Year of Hegira.	Commencement (1st of Muharram).		
1351	Sat.	7 May	1932
1352*	Wed.	26 April	1933
1353	Mon.	16 April	1934
1354	Frid.	5 April	1935
1355*	Tues.	24 Mar.	1936
1356	Sun.	14 Mar.	1937
1357*	Thur.	3 Mar.	1938
1358	Tues.	21 Feb.	1939
1359	Sat.	10 Feb.	1940
1360*	Wed.	29 Jan.	1941
1361	Mon.	19 Jan.	1942
1362	Frid.	8 Jan.	1943
1363*	Tues.	28 Dec.	1943
1364	Sun.	17 Dec.	1944
1365	Thur.	6 Dec.	1945
1366*	Mon.	25 Nov.	1946
1367	Sat.	15 Nov.	1947
1368*	Wed.	3 Nov.	1948
1369	Mon.	24 Oct.	1949
1370	Frid.	13 Oct.	1950
1371*	Tues.	2 Oct.	1951
1372	Sun.	21 Sept.	1952
1373	Thur.	10 Sept.	1953
1374*	Mon.	30 Aug.	1954
1375	Sat.	20 Aug.	1955
1376*	Wed.	8 Aug.	1956
1377	Mon.	29 July	1957
1378	Frid.	18 July	1958
1379*	Tues.	7 July	1959
1380	Sun.	26 June	1960

47th Cycle.

Year of Hegira.	Commencement (1st of Muharram).		
1381	Thur.	15 June	1961
1382*	Mon.	4 June	1962
1383	Sat.	25 May	1963
1384	Wed.	13 May	1964
1385*	Sun.	2 May	1965
1386	Frid.	22 April	1966
1387*	Tues.	11 April	1967
1388	Sun.	31 Mar.	1968
1389	Thur.	20 Mar.	1969
1390*	Mon.	9 Mar.	1970
1391	Sat.	27 Feb.	1971
1392	Wed.	16 Feb.	1972
1393*	Sun.	4 Feb.	1973
1394	Frid.	25 Jan.	1974
1395	Tues.	14 Jan.	1975
1396*	Sat.	3 Jan.	1976
1397	Thur.	23 Dec.	1976
1398*	Mon.	12 Dec.	1977
1399	Sat.	2 Dec.	1978
1400	Wed.	21 Nov.	1979
1401*	Sun.	9 Nov.	1980
1402	Frid.	30 Oct.	1981
1403	Tues.	19 Oct.	1982
1404*	Sat.	8 Oct.	1983
1405	Thur.	27 Sept.	1984
1406*	Mon.	16 Sept.	1985
1407	Sat.	6 Sept.	1986
1408	Wed.	26 Aug.	1987
1409*	Sun.	14 Aug.	1988
1410	Frid.	4 Aug.	1989

48th Cycle.

Year of Hegira.	Commencement (1st of Muharram).		
1411	Tues.	24 July	1990
1412*	Sat.	13 July	1991
1413	Thur.	2 July	1992
1414	Mon.	21 June	1993
1415*	Frid.	10 June	1994
1416	Wed.	31 May	1995
1417*	Sun.	19 May	1996
1418	Frid.	9 May	1997
1419	Tues.	28 April	1998
1420*	Sat.	17 April	1999
1421	Thur.	6 April	2000
1422	Mon.	26 Mar.	2001
1423*	Frid.	15 Mar.	2002
1424	Wed.	5 Mar.	2003
1425	Sun.	22 Feb.	2004
1426*	Thur.	10 Feb.	2005
1427	Tues.	31 Jan.	2006
1428*	Sat.	20 Jan.	2007
1429	Thur.	10 Jan.	2008
1430	Mon.	29 Dec.	2008
1431*	Frid.	18 Dec.	2009
1432	Wed.	8 Dec.	2010
1433	Sun.	27 Nov.	2011
1434*	Thur.	15 Nov.	2012
1435	Tues.	5 Nov.	2013
1436*	Sat.	25 Oct.	2014
1437	Thur.	15 Oct.	2015
1438	Mon.	3 Oct.	2016
1439*	Frid.	22 Sept.	2017
1440	Wed.	12 Sept.	2018

49th Cycle.

Year of Hegira.	Commencement (1st of Muharram).		
1441	Sun.	1 Sept.	2019
1442*	Thur.	20 Aug.	2020
1443	Tues.	10 Aug.	2021
1444	Sat.	30 July	2022
1445*	Wed.	19 July	2023
1446	Mon.	8 July	2024
1447*	Frid.	27 June	2025
1448	Wed.	17 June	2026
1449	Sun.	6 June	2027
1450*	Thur.	25 May	2028
1451	Tues.	15 May	2029
1452	Sat.	4 May	2030
1453*	Wed.	23 April	2031

49th Cycle—*continued.*

Year of Hegira.	Commencement (1st of Muharram.)			Year of Hegira.	Commencement (1st of Muharram.)		
1454	Mon.	12 April	2032	1463	Frid.	4 Jan.	2041
1455	Frid.	1 April	2033	1464*	Tues.	24 Dec.	2041
1456*	Tues.	21 Mar.	2034	1465	Sun.	14 Dec.	2042
1457	Sun.	11 Mar.	2035	1466*	Thur.	3 Dec.	2043
1458*	Thur.	28 Feb.	2036	1467	Tues.	22 Nov.	2044
1459	Tues.	17 Feb.	2037	1468	Sat.	11 Nov.	2045
1460	Sat.	6 Feb.	2038	1469*	Wed.	31 Oct.	2046
1461*	Wed.	26 Jan.	2039	1470	Mon.	21 Oct.	2047
1462	Mon.	16 Jan.	2040				

TABLE X.—*Principal Days of the Hebrew Calendar.*

Tisri	1,	New Year, Feast of Trumpets.
,,	3,[1]	Fast of Guedaliah.
,,	*10,*	*Fast of Expiation.*
,,	15,	Feast of Tabernacles.
,,	21,	Last Day of the Festival.
,,	22,	Feast of the 8th Day.
,,	23,	Rejoicing of the Law.
Kislev	25,	Dedication of the Temple.
Tebet	10,	Fast, Siege of Jerusalem.
Adar	13,[2]	Fast of Esther, } In embolismic
,,	14,	Purim, } years. Veadar.
Nisan	15,	Passover.
Sivan	6,	Pentecost.
Tamuz	17,[1]	Fast, Taking of Jerusalem.
Ab	9,[1]	Fast, Destruction of the Temple.

TABLE XI.—*Principal Days of the Mahometan Calendar.*

Muharram	1,	New Year.
,,	10,	Ashura.
Rabia I.	11,	Birth of Mahomet.
Jomada I.	20,	Taking of Constantinople.
Rajab	15,	Day of Victory.
,,	20,	Exaltation of Mahomet.
Shaaban	15,	Borak's Night.
Shawall	1, 2, 3,	Grand Bairam.
Dulheggia	1,	Kurban Bairam.

TABLE XII.—*Epochs, Eras, and Periods.*

Name.	Christian Date of Commencement.	Name.	Christian Date of *Commencement.*
Grecian Mundane era, .	1 Sep. 5598 B.C.	Sidonian era, .	Oct. 110 B.C.
Civil era of Constantinople, .	1 Sep. 5508 ,,	*Cæsarean era of* Antioch, .	1 Sep. 48 ,,
Alexandrian era, . . .	29 Aug. 5502 ,,	Julian year, .	1 Jan. 45 ,,
Ecclesiastical era of Antioch, . .	1 Sep. 5492 ,,	Spanish era, .	1 Jan. 38 ,,
Julian Period,	1 Jan. 4713 ,,	Actian era, .	1 Jan. 30 ,,
Mundane era, .	Oct. 4008 ,,	Augustan era, .	14 Feb. 27 ,,
Jewish Mundane era, .	Oct. 3761 ,,	Vulgar Christian era, . .	1 Jan. 1 A.D.
Era of Abraham	1 Oct. 2015 ,,	Destruction of Jerusalem, .	1 Sep. 69 ,,
Era of the Olympiads, .	1 July 776 ,,	Era of Maccabees, . . .	24 Nov. 166 ,,
Roman era, .	24 April 753 ,,	Era of Diocletian, . . .	17 Sep. 284 ,,
Era of Nabonassar, . .	26 Feb. 747 ,,	Era of Ascension, . . .	12 Nov. 295 ,,
Metonic Cycle,	15 July 432 ,,	Era of the Armenians, .	7 July 552 ,,
Grecian or Syro-Macedonian era, . . .	1 Sep. 312 ,,	Mahometan era of the Hegira,	16 July 622 ,,
Tyrian era. .	19 Oct. 125 ,,	Persian era of Yezdegird, .	16 June 632 ,,

[1] If Saturday, substitute Sunday immediately following.
[2] If Saturday, substitute Thursday immediately preceding.

The principal works on the calendar are the following:—Clavius, *Romani Calendarii a Gregorio XIII. P. M. restituti Explicatio*, Rome, 1603; *L'Art de vérifier les Dates;* Lalande, *Astronomie*, tom. ii.; *Traité de la Sphère et du Calendrier*, par M. Revard, Paris, 1816; Delambre, *Traité de l'Astronomie Théorique et Pratique*, tom. iii.; *Histoire de l'Astronomie Moderne; Methodus technica brevis, perfacilis, ac perpetua construendi Calendarium Ecclesiasticum, Stylo tam novo quam vetere, pro cunctis Christianis Europæ populis, &c.*, auctore Paulo Tittel, Göttingen, 1816; *Formole analitiche pel calcolo della Pasqua, e correzione di quello di Gauss, con critiche osservazioni su quanto ha scritto del Calendario il Delambri*, di Lodovico Ciccolini, Rome, 1817; E. H. Lindo, *Jewish Calendar for Sixty-four Years*, 1838; W. S. B. Woolhouse, *Measures, Weights, and Moneys of all Nations*, 1869. (T. G.—W. S. B. W.)

CALENDER, a mechanical engine employed for dressing and finishing cloths and various descriptions of fabrics, preparatory to sending them into the market. It is also used by calico-printers to prepare the surface of their cloths for the operations of printing. The first object of calendering is to produce in the cloth as perfect extension and smoothness of surface as can be attained,—so that no wrinkle or doubled folding may remain in it. The second end attained by the calendering of cloth is the compression of the yarn or threads of which the texture is composed, which in some degree divests them of their cylindrical shape, and reduces them to a degree of flatness, which, by bringing them more closely into contact with each other, gives to the fabric a greater appearance of closeness and strength than it would otherwise possess. The operation of the calender also improves the superficial appearance, by flattening down all knots, lumps, and other imperfections, from which no material from which cloth is fabricated can ever be entirely freed during the previous processes of spinning and weaving. And, thirdly, in certain fabrics it is desirable that cloth should receive, by means of friction, an additional lustre or polish, which is distinguished by the appellation of glazing. For the accomplishment of these objects the agencies on which the calenderer has to rely are moisture, heat, pressure, and friction, and these he variously combines to produce many different effects.

The term calender, which really means only the chief mechanical engine employed, gives the general name to the finishing establishments where all the varied operations of cloth-lapping are carried on; and it is as usual to say that goods are *packed* as that goods are *dressed* at a calender. The common domestic smoothing-iron may be regarded as a form of calendering utensil; as is also the old-fashioned domestic mangle, which consists of a cylinder applied to a plane, upon which it is rolled backward and forward, until some degree of smoothness is produced by this reciprocating motion. A form of mangle, consisting of an enormously heavy cylinder, which is worked forwards and backwards over a plane surface, is still used in calendering establishments for the finishing of very heavy linens and similar goods.

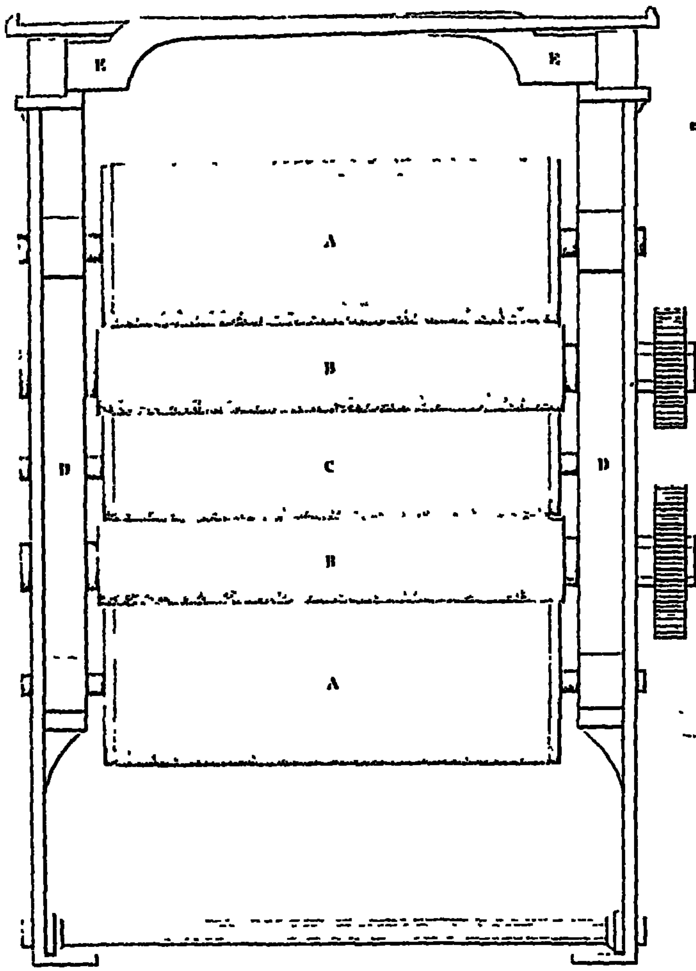
The smoothing calender completes the substitution of cylindrical for plane surfaces, all the parts which operate upon the cloth being of that form. This ingenious engine, which was introduced into Britain from Flanders and Holland during the persecution of the Huguenots, has, since its introduction and adoption, undergone no very material or important alteration or improvement in point of theoretical principle; nor, until the extension of the cotton manufacture had introduced a general spirit of mechanical improvement, were any great advances made in the practical applications of it

Calenders are constructed with from two to five rollers or cylinders, technically termed "bowls,"—three or five-bowl calenders being most frequently employed. The materials of which these cylinders are made are wood, compressed paper, and metal, such as chilled cast-iron, brass, or copper. They are variously arranged in relation to each other, and as mechanical arrangements are required—1st, for varying pressure; 2d, for applying heat within a metal bowl from steam, hot iron, or burning gas; and 3d, for varying the rate of motion of a pair of the bowls so as to produce friction—the gearing of a calender is somewhat complex. Commonly a three-bowl calender has an upper and under cylinder of paper, the central one being of metal, and in such an implement either two pieces may pass through at the same time, or one piece may receive two pressures. An ordinary five-bowl calender has the first, third, and fifth cylinders of paper, the intermediate being of metal, and here four successive pressures may be given. Fig. 1, Plate XXXII., is an elevation of a five-roller calender for finishing cloth. A, A are two paper rollers, of 20 inches diameter each. B, B are two cast-iron cylinders, externally turned until perfectly smooth; their diameter is 8 inches, allowing the substance of iron to be 2 inches, and leaving a perforation of 4 inches diameter. C is a paper roller of 14 inches diameter; D, D is the framing of cast-iron for containing the bushes in which the journals of the rollers revolve; E, E are two levers by which the rollers are firmly pressed together while the cloth is passing through.

Fig. 2 is an end view of the same calender, with the wheels for glazing cloth. The wheel on the upper cylinder is 10 inches diameter, the wheel on the under cylinder is 13 inches diameter; they are connected by the wheel F, which communicates the speed of the upper cylinder, so that the wheel on the under cylinder being nearly one-third of an inch more in diameter, the difference of their motions retards the centre paper roller, by which means the upper cylinder passes over the cloth one-third faster than the cloth passes through the calender, and polishes it in consequence.

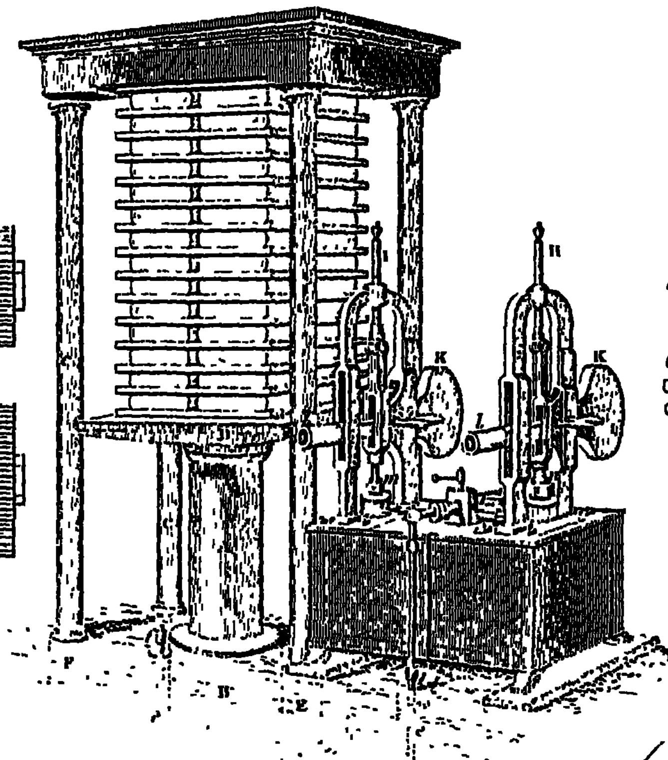
The construction of paper or pasteboard rollers for calenders is a process of great interest and importance. The frequent heating and cooling to which the apparatus is subject necessarily produces warping and splitting in wooden bowls, which are thereby rendered useless, but the substitution of paper afforded a radical cure for these defects as well as a collateral advantage arising from its being susceptible of a much higher degree of superficial polish, which is always transferred to the cloth. In the construction of paper cylinders an axis or journal of malleable iron and two circular plates of cast-iron of the same diameter as the cylinder to be made are, in the first place, provided. A plate is secured on one end of the journal. The entire space between the two iron plates is then to be filled with circular pieces of paper or pasteboard, exceeding by about 1 inch in diameter the iron plates, and having each a correspondent perforation, through which the iron journal passes. A cylinder is thus formed, the substance of which is of paper locked together by plates of iron at the extremities, and susceptible of immense compression which it receives in a hydraulic press. After undergoing this preparation, the cylinder is exposed to strong heat in a confined apartment in which the paper contracts and becomes loose. It is again put into the press, more sheets of paper are added, and this process goes on till the cylinder has gradually acquired the requisite compression. It is then re-exposed to the ordinary temperature of the atmosphere, and by its re-expansion presents a body almost remarkably compact, its specific gravity in this state being greater than even that of silver.

Fig. 1



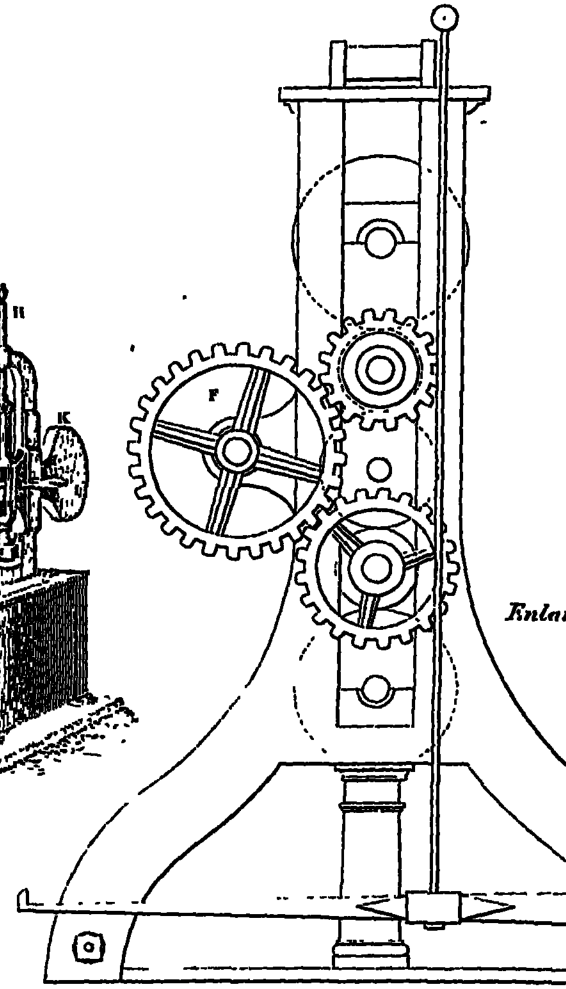
Five-bowl Calender - front elevation

Fig. 3.



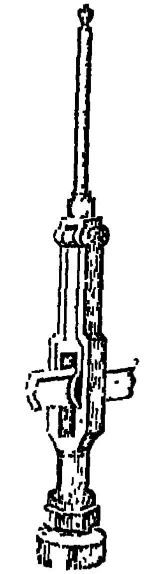
Hydraulic Press

Fig. 2.



Five-bowl Calender, - side elevation.

Fig. 4.



Enlargement of H & L
Fig. 3.

The only operation now required is that of turning its superficies until correctly cylindrical; and this is a work of immense labour and patience.

For dressing muslins, gauzes, lawns, and other goods of a light kind, a smaller species of calender is employed. It consists of only three cylinders of equal diameter (generally about 6 inches), and is easily moved by a common winch or handle. The middle cylinder is iron, and the others are of wood or pasteboard. All the cylinders are of equal diameter, and are moved with equal velocities by means of small wheels. This machine is always used in a cold state.

By means of the calender, also, is produced the waved or watered surface, known as *moiré* among the French, and best seen in the silk textures called moire antique, and in woollen moreens. The effect is produced in a variety of ways, the principal method employed consisting of passing two webs laid above each other through the calender at the same time. The threads of the web not running perfectly parallel to each other are at some places superimposed, and at other points they fit into alternate spaces,—the result being that at the places where the threads press directly on each other a higher gloss is produced, which gives the watered appearance to the texture. Watering is also effected on a single thickness of material by moving the web to the right and left as it enters the calender, and thus varying the direction in which it travels over a bowl on which there are a series of engraved lines running in a parallel direction. Embossed patterns, or imitations of the grain of leather, &c., for bookbinders' cloth, are produced by means of a calender having a bowl of brass or other metal on which the pattern is engraved. When a paper cylinder is used along with an embossing cylinder, the paper must be turned into such exact proportion to the embossed bowl that it will repeat the pattern accurately on its circumference, so that the depressions on the one bowl always fit accurately into the elevations on the other. For many purposes a covering of leather, felt, or lead is used for the cylinder which works against that on which the pattern is engraved.

Goods after passing through the calender are folded, either by machinery or on long pins by hand-working into a variety of forms according to their nature and destination, and when so folded they are submitted to a very powerful compression either in a screw-press or in an hydraulic press.

Fig. 3, Plate XXXII., is a perspective view of an hydraulic press. A is the piston, 8 inches diameter, working in the cylinder B, and kept water-tight by passing through a collar of leather; D, a cast-iron plate raised by the piston A, between which and the entablature E, E the goods to be pressed are laid; C, C, C, C, four malleable iron columns, $2\frac{3}{4}$ inches diameter, having screwed ends, with nuts, by which the entablature and the base F, F are firmly connected together; G, a cistern for holding water to supply the two force-pumps H and I, the largest of which has a piston $1\frac{1}{2}$ inch diameter, and the other one of $\frac{1}{2}$ inch diameter, which is used to give the highest pressure; K, K, weights to balance the pump-handles which fit into the sockets at *l*, *l*. The pistons of the force-pumps are made water-tight by collars of leather, kept in their place by the screwed pieces *m* and *n*. *e*, *e*, *e* is a pipe communicating with the pumps and the large cylinder B; there is a stopcock at *f*, which shuts this communication when required.

Fig. 4 is an enlarged view of the force-pump piston, to show the method of keeping the rod parallel.

An illustration of a glazing calender as used by bleachers and calico-printers, with further details as to finishing processes, will be found under Bleaching. See also Calico-Printing.

CALEPINO, Ambrogio (1435-1511), an Augustine monk, born at Bergamo in 1435, was descended of an old family of Calepio, whence he took his name. He devoted his whole life to the composition of a *polyglott dictionary*, first printed at Reggio in 1502. This gigantic work was afterwards augmented by Passerat and others. The most complete edition, published at Basel in 1590, comprises no fewer than eleven languages. The best edition is that published at Padua in seven languages in 1772. Calepino died blind in 1511.

CALHOUN, John Caldwell (1782-1850), a leading politician of the United States, was grandson of an Irish Presbyterian, who founded Calhoun settlement, in the district of Abbeville, South Carolina. It was there that John Calhoun was born in 1782. For some years he assisted his widowed mother in the management of her farm, but at the age of eighteen he commenced to study for the bar. He graduated with honours at Yale College, and spent eighteen months at Litchfield, at that time the only law school in the country. He then returned to practise in his native district of Abbeville. While there, in June 1807, the searching of the Chesapeake having aroused strong feeling in America, Calhoun drew up for a public meeting a resolution expressive of indignation against Great Britain, and supported it in a speech of such power that he was soon after elected a member of the legislature, and in November 1811, became member of Congress, where he continued to be an enthusiastic and prominent adherent of the war party. For seven years (commencing with 1817) he acted with credit as secretary of war under Monroe; in 1825 he became Vice-President of the United States under J. Quincy Adams; and in 1829 he was re-elected under General Jackson. He now began to be looked upon as champion of the South; and, though he had supported the protective tariff of 1816, he became an eager advocate of free-trade,—that policy being, even popularly, recognized as specially advantageous to the cotton-growing States. He is, however, best known as a strenuous defender of slavery, and as the author of a doctrine to which the Civil War may be traced,—the doctrine of "nullification," according to which each State has the right to reject any act of Congress which it considers unconstitutional. This view was in 1829 adopted by the legislature of his native State, and drawn up in a document, mainly prepared by Calhoun, which was known as the "South Carolina Exposition," and which was approved by Virginia, Georgia, and Alabama. In 1832 the legislature of South Carolina carried the theory into practice by passing laws nullifying the obnoxious tariff of that year; but its opposition was crushed by the firmness of General Jackson, who declared that he would resort to force, if necessary. The most important of the other political acts of Calhoun are his defence of the right of veto which belongs to the president, his advocacy of the annexation of Texas, and his maintenance of the cause of peace, when war with Great Britain was threatened by the claims of the United States to Oregon. He died at Washington on the 31st March 1850. His works, with memoir, were published posthumously in 6 vols. in 1853-4, by Richard K. Cralle, who had been his amanuensis. They include a dissertation *On the Constitution and Government of the United States*; and from this book we learn that he advocated the election of two presidents, one by the free and another by the slave States, the consent of both of whom should be essential to the passing of any law. Calhoun's speeches were always directly to the point, clear, and forcible, while he seldom indulged in the imaginative or purely rhetorical. The integrity and worth of his character have been spoken of in the highest terms even by political opponents.

CALICO-PRINTING

CALICO-PRINTING is the process of imprinting on textile fabrics patterns of one or more colours on a white or coloured ground. Though, as the name implies, the art is directed primarily, as it is by far most extensively, to calico or cotton textures, the same methods of ornamentation are also employed for certain woollen, linen, and silk fabrics, and the process of printing is also applied to unwoven yarns, notably in the case of worsted yarns intended for use in the weaving of tapestry carpets. But as certain of the processes employed for printing cotton agree essentially with those used for woollen and silk fabrics, it will be unnecessary here to refer specially to any other than the methods employed in the printing of calico proper.

There is a curious passage in *Pliny's Natural History* (xxxv. 42), from which it is evident that calico-printing in his time (the 1st century) was understood and practised in Egypt. The following is a translation of this passage:—

"There exists in Egypt a wonderful method of dyeing. The white cloth is stained in various places, not with dye-stuffs, but with substances which have the property of absorbing (fixing) colours. These applications are not visible upon the cloth; but when the pieces are dipt into a hot caldron containing the dye, they are drawn out an instant after dyed. The remarkable circumstance is, that though there be only one dye in the vat, yet different colours appear on the cloth; nor can the colours be afterwards removed. A vat which would of itself only confuse the colours on cloth previously dyed, in this way imparts several colours from a single dye-stuff, painting as it boils." It is evident enough that the substances employed to stain the cloth, as Pliny expresses it, were different mordants, which served to fix the dye upon the cloth. Thus if we suppose certain parts of a piece of cotton cloth to be impregnated with alumina, and the cloth afterwards dyed with madder, after the clearing, those parts only impregnated with the mordant would retain their red colour, while the remaining parts will continue white.

The general opinion is, that this ingenious art originated in India, and from that country made its way into Egypt. Whether this notion be well or ill founded, it is certain that calico-printing was known and executed by the Indians at a very early period. Their colours were beautiful and fast, and the varieties of pattern and the number of colours which they knew how to fix on different parts of the cloth gave to their printed calicoes a beauty and a value of no ordinary kind; but their processes are so tedious and so clumsy that they could be put in practice only where labour was exceedingly cheap.

It was not till towards the close of the 17th century that calico-printing was introduced from India into Europe, having probably been practised first in Holland, to which country a knowledge of the art was carried by the Dutch East India Company. Evidence exists which shows that calico-printing was commenced in the neighbourhood of London so early as the year 1676, and there the art continued long to be practised. In 1738 it extended to Scotland, and took firm root in the country around Glasgow, but it was not till 1764 that it was introduced to what is now its chief centre, Lancashire. The extent of the industry in Great Britain at the present day is probably unequalled by the combined production of all other nations of the world. The other European countries where the art is prosecuted to any considerable extent are France, Switzerland, and Germany, to the last of which the annexation of the Rhine Provinces, consequent on the war of 1870-1, has added a famous centre of the industry. The art is also extensively cultivated in the United States, while Oriental communities still continue to prosecute it in their own peculiar fashions.

In Europe the art has been in a great measure created anew. By the application of machinery, and by the light thrown on the processes by the progress of chemistry, the tedious methods of the Indians have been wonderfully simplified; and the processes are remarkable for the rapidity with which they are now executed, and for the beauty, fastness, and variety of the colours which are applied on the surface of cotton. So great have been these improvements, that at the present time in Manchester a piece (25 yds.) of calico can be printed in the short period of one minute; and the quantity of calicoes printed in Great Britain in one year cannot measure less than three quarters of a million of miles, seeing the exports alone of printed cotton piece goods during the year 1874 amounted to 1,003,101,107 yards, of a value of £19,602,706, an amount exceeded by 140,000,000 yards in 1872.

Grey calico is prepared for printing by an elaborate process of BLEACHING, for the details of which the reader is referred to the article under that head, vol. iii. p. 811. The bleached cloth previous to printing is generally passed through a shearing machine, which removes from its surface the fine downy pile and short threads, thus preparing a smooth uniform surface capable of taking a sharp distinct impression from the engraved printing-blocks or rollers. The printing processes which follow are exceedingly complex and varied, demanding for their proper execution an extended range of chemical knowledge and mechanical ingenuity; and as commercial success depends largely on the tasteful and harmonious colouring of patterns, no little artistic ability and discrimination is required for the efficient superintendence of such works.

There are two modes of printing,—namely, *block-printing* and *machine-printing*. The former has been practised from time immemorial; the latter is a modern invention, and originated after the introduction of the art of printing into Great Britain. In the case of block-printing the figure intended to be communicated to the cloth is cut out upon a block of sycamore, the parts which are to make the impression being left prominent, and the rest of the block cut away, just as practised for wood engravings. When the figure is too complicated, and the lines too fine, to admit of being cut in wood, it is made by means of small pieces of copper, which are very ingeniously driven into the block, and the interstices are filled up with felt.

By means of a modern invention several colours may be applied at once on the cloth by means of one block. The machine used for this purpose, which is called a "toby," consists of a box divided into several compartments filled with various colours, which are in communication through tubes with bottles filled with the same colours; and by means of a gentle pressure the colouring fluid in each of the compartments of the machine is propelled through the felted cloth which covers each compartment. The block, being pressed against the cloth, takes the colour which is to be conveyed to the white calico by the block-printer.

By Continental printers an intricate apparatus for printing called the Perrotine, from the name of its inventor, is employed; but it has never been introduced to any considerable extent in England. In this machine the intended figures are engraved upon a flat copper plate of about a square yard or more in size. Upon this plate the

colour to be applied is spread. The plate is then pulled backwards, the excess of colour being removed by a "doctor," and the colour remaining on the engraving is then printed on the white cloth.

Printing is now almost universally accomplished by means of cylinder machines, in which the impression is given by one or a series of engraved copper cylinders; a different cylinder being required for each separate colour or shade in the pattern. The cylinders are made about 3 feet 6 inches long and 6 inches in diameter; and in establishments of any considerable extent many thousands of these are kept in stock, involving an enormous outlay of capital. There are three different methods in practice for engraving patterns or portions of patterns on the cylinders. In the first, the "die and mill" process, a cylindrical steel die is engraved with the pattern, which is afterwards transferred to a "mill" or cylinder of soft steel. The pattern on the mill is in relief, and after hardening it is by pressure impressed into the copper roller. The diameter of the mill is such that the repeats of the pattern fit with the utmost precision when transferred to the copper roller. The "die and punch" process is a modification of the foregoing, in which small patterns are impressed on the copper cylinder by means of a punch which has the pattern in relief transferred to it from a sunk steel die. The third process by which engraved rollers are prepared is by the aid of the pentagraph, a most complex and ingenious machine, with which by the movement of a single tracer in the deep lines of an enlarged pattern cut in a zinc plate, these lines are reproduced on the original scale, traced at five different places through a coating of bituminous varnish on the surface of the cylinder. After the engraving is complete, the cylinder is placed in a bath of dilute nitric acid, by which the pattern is bitten in along the surfaces of the metal exposed by the scratching of the pentagraph points.

Calico-printing machines are arranged to print with any number of such cylinders, from one up to as many as twenty; but in practice few machines carrying more than eight cylinders are employed. The accompanying diagrammatic section (fig. 1.) illustrates the arrangements necessary for printing one colour, and each of the separate colours on a machine is similarly mounted round the periphery of the central bowl or cylinder *a*. Against this central bowl *a* the engraved copper cylinder *b* presses, and between them the cloth to be printed and a thick cloth or blanket pass. The cylinder is supplied with the printing material by means of a furnishing roller *c*, which revolves in the colour-box *d*. The superfluous colour is removed from the cylinder by means of the colour doctor *e*, a steel blade which fits closely to the surface of the roller, and removes all colour except that which fills the engraved portions. The lint doctor *f* similarly removes all impurities which adhere to the roller after it has communicated its impression to the cloth. Fig 2 shows the elevation of a six-colour machine by Messrs Mather and Platt of Manchester, to whose courtesy we are indebted for illustrations of the most recent and approved forms of apparatus. The essential parts of this machine consist of the central iron bowl or cylinder A, and the six radiating arms B, each of which holds in position an engraved roller colour-box, &c., as shown in diagram fig. 1. By means of screws and other fine mechanical adjustments the pitch of each roller can be arranged so that its particular colour falls on the proper place with the utmost exactitude, producing a perfect pattern. In printing, the white calico is batched at C, and the cloth D passes inwards over tension rails, proceeding round the periphery of the bowl A, receiving from each roller B a separate colour or mordant, and issuing at D', printed and ready for the further processes to be hereafter detailed. Around the central bowl A are lapped, for the sake of elasticity, several folds of cloth. Between the central bowl and the cloth to be printed there passes, 1st, an endless band of cloth or blanket, seen entering at E and issuing at E'; and 2d, a "grey back" or web of unbleached calico, used to keep the blanket clean, which enters at F and issues at F'.

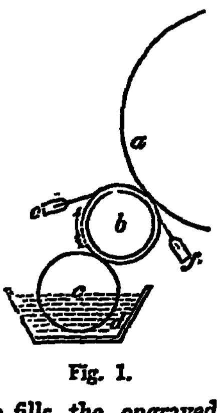


Fig. 1.

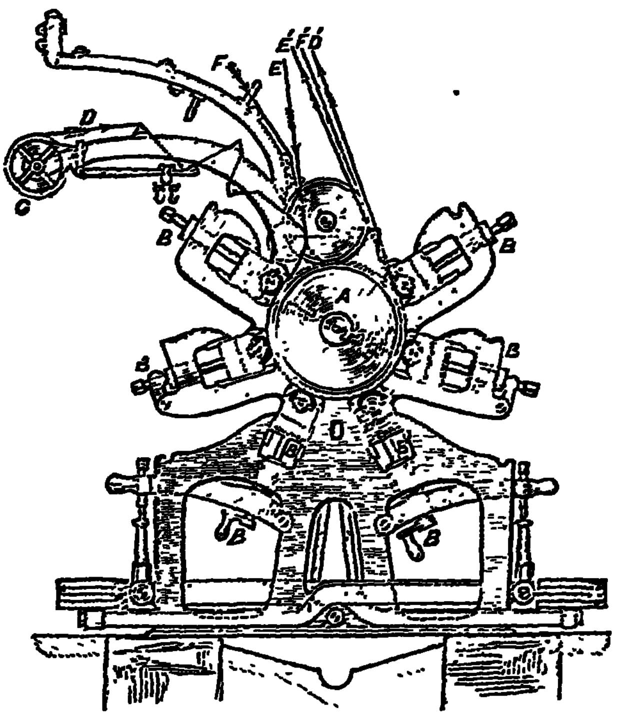


FIG. 2.—Cylinder Printing-Machine—six colours.

By whatever mechanical means the printing is performed, whether by hand-block, perrotine, or cylinder machine, the effect is precisely the same, and the colours or mordants employed are in all cases alike. The substances to be printed on the surface of the calico have to be brought to a proper consistency for printing by means of thickeners, with which they are mixed up in colour pans. Although these are only mechanical agents, it is found in the practical operation of printing that particular thickeners are more suitable for certain colours or mordants than others, and the printer is guided by experience in selecting that thickening adjunct which gives the clearest impression. Among the numerous thickeners available, those most commonly employed are wheat flour and starch, potato starch, dextrin or British gum, and gum-senegal or other varieties of gum-arabic. The mordant or the colour and its appropriate thickeners are placed in a range of colour pans, in which the materials are thoroughly incorporated. A pair of these pans (one in section), as constructed by Messrs Mather and Platt, embracing the most recent and approved appliances, is shown in fig. 3. In the cut, A represents the driving pulleys, B the driving shaft, wheels, and catch-box, *c* wheels for giving a rotary motion to the brass stirrers *d*. E is the colour pan, of copper, double cased, made to swivel on centres or pivots f^1 and f^2. Through f^1 water and through f^2 steam are supplied to the space between the outer and inner body of the pan for the purpose of boiling and cooling down the contents of the pan alternately as required. The supply of steam or

of water to these pipes is regulated by the tap g. H is the framing, J stands, with the necessary appliances for turning over the pans to empty their contents, K a pipe and swivel tap for supplying water to the pans. L is the main steam pipe to f^1, m the water pipe to f^2 and K, and n and o are taps for washing out and for condense water respectively.

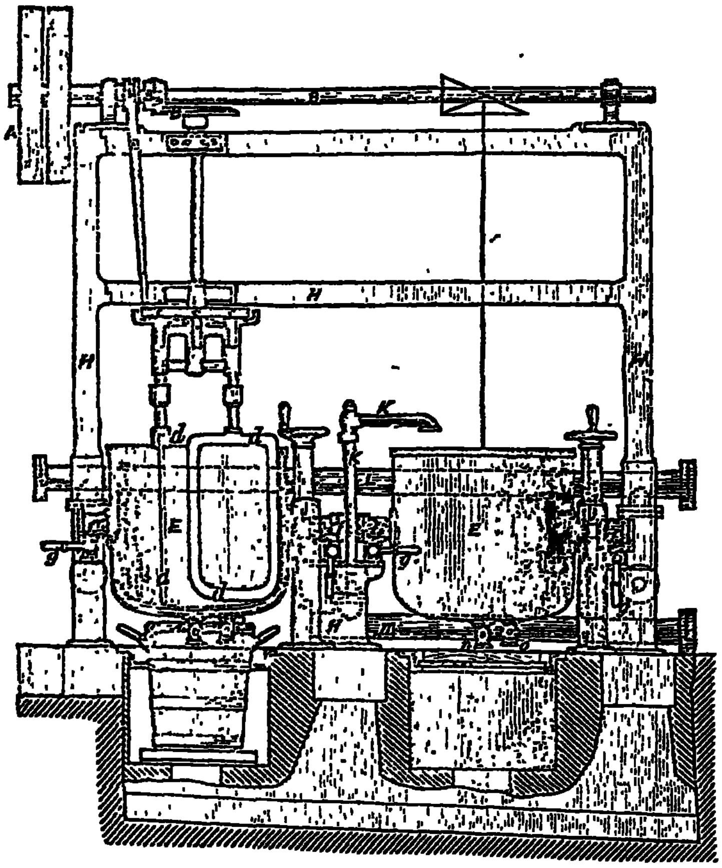


Fig. 3.—Colour Pans.

The variety of methods by which colours are produced on calicoes is almost endless, and the processes employed, both chemical and mechanical, as well as the tinctorial agents used, are also very numerous and diversified. The processes are in practical works generally classified under the heads of numerous different styles, combinations of several of which are frequently employed in the production of a single pattern It is at once impossible and unnecessary to enter into details of these various styles here; but they all resolve themselves into a few general groups, under which heads they will be briefly treated of. In certain styles a mordant, or chemical substance, which possesses an affinity for both the cloth and the dye-stuff, is the substance printed in the cylinder machine, and the calico has to undergo a subsequent process of dyeing by which those portions of the cloth which received the mordant are alone permanently dyed Again, the colour-box may contain all the ingredients necessary for the production of the colour, but to develop it in the fibre it is necessary to expose the printed cloth to the oxidizing influence of the atmosphere, or otherwise produce an oxidation of the dye-stuff by which the colour is developed and fixed. By a third process the colour is prepared and applied direct to the cloth mixed with some agent which, under the influence of heat and moisture, either mechanically attaches or chemically precipitates the colour in the fibre. And a fourth process, which may be regarded as a modification of the third, consists of mixing the dye with powerful mordanting substances, which, after printing, are merely dried, the mordant volatilizing sufficiently to fix the dye, not very fast, on the cloth. There are thus these four divisions—

I. Dye colours.
II. Oxidation colours.
III. Steam colours.
IV. Spirit colours.

Along with these different methods patterns are also produced and modified by means of substances applied to cloth already dyed or printed in order to remove the colour from certain portions of it which are either intended to remain white, or to receive some other colour afterwards. These substances are known as "discharges," and examples of their action are seen in printed Turkey reds and bandannas.

Sometimes a substance is applied to cloth before it is dyed, in order to prevent the indigo, or any other colour, from being fixed on those parts to which it is applied, that they may remain white, or be afterwards made to receive other colours. Substances possessed of this property are called "resists."

Dye Colours.

Under this head are included prints prepared by printing the pattern in one or more mordants—substances which have an affinity for the fibre on the one hand and the dye-stuff on the other. The mordanted cloth is subsequently submitted to a process of dyeing, when the dye-stuff is fixed only on such parts of the cloth as have been impregnated with the mordant. By using more than one mordant, by mixing them, or by employing the same at different degrees of strength, a variety of shades or colours is produced in the process of dyeing with one dye-stuff.

Mordants.—The principal mordants employed for dye colours are the following :—

1. *Red Liquor.*—The acetate of alumina mordant or "red liquor" of the calico-printer is prepared by partly decomposing alum, held in solution by impure acetate of lime, commonly called pyrolignite of lime; sulphate of lime precipitates and acetosulphate of alumina is thus obtained. Red liquors thus prepared have a specific gravity of 1·08, and are composed as follows :—

Composition of four red Mordants per Gallon.

Substances.	Mordant A.		Mordant B.		Mordant C.		Mordant D.	
	grains.	oz. grs	grains.	oz. grs.	grains.	oz. grs.	grains.	oz. grs.
Alumina ..	1680 0	3 367	1830 0	4 80	1239 0	2 364	2164 4	4 414
Sulphuric acid	2642 5	6 20	2800 0	6 175	3017 0	6 392	1664 6	3 352
Acetic acid	3369 8	7 307	3970 0	9 32	1281 7	2 406	3679 2	8 179
Ammonia and water	674 1	1 236	910 0	2 35	693 1	1 255	...	...

In the manufacture of "red liquor," sulphate of alumina is frequently substituted for alum, and acetate of lead for pyrolignite of lime.

2. *Iron Liquor.*—The oxides of iron are much used as mordants, either in the state of protoxide or peroxide. The salt most employed is the impure pyrolignite of protoxide of iron, which is prepared either by decomposing green copperas with pyrolignite of lime, or by placing in large vats pyrolignous acid and old iron, when, after a few months, the iron, which is gradually oxidized, dissolves in the acid, and gives rise to pyrolignite of protoxide of iron. This valuable mordant is thickened with calcined farina, flour, starch, or gum, and applied on the calico. After being exposed for a few days in a moist atmosphere, it loses a part of the acid, and becomes partially peroxidized. Pyrolignite of iron of the specific gravity of 1·05 gives a black with madder and several "tannin" substances. Various shades of purple are obtained by adding different proportions of water to the mordant previously to applying it to the cloth; and various shades of chocolates are produced by mixing this with the alumina mordant previously described, and then dyeing also with madder.

These two mordants are the principal employed for madder colours; but several others are employed for special shades. Among these may be enumerated the aluminate

of soda or alkaline pink (used as a mordant when it has to act as a resist for another colour such as aniline black), and acetates of chromium, copper, tin, and other metals.

Dye Colours.—The principal dye colour is madder or some of its derivatives, including artificial alizarin, the dyeing principle of madder obtained synthetically from anthracene. Madder is the root of a plant, *Rubia tinctoria*, a native of Central Asia, but introduced and extensively cultivated in south Europe, especially at Avignon in France. For the purposes of the calico-printer, madder-root is prepared by simply grinding, or in the form of flowers of madder (*fleurs de garance*), of garancin, of garanceux, or of alizarin. Fleurs de garance is powdered madder deprived of its soluble constituents and redried, whereby the tinctorial strength of the preparation is increased nearly one-half. Garancin is prepared by boiling powdered madder in sulphuric acid; garanceux is spent madder similarly prepared; and alizarin, the chief tinctorial principle of madder, is obtainable from garancin by the action of superheated steam. Among the chemical principles of tinctorial value yielded by madder there is, besides alizarin, an allied substance named purpurin. Alizarin of precisely similar composition and behaviour is now artificially made from anthracene, one of the products of coal-tar, and purpurin also is obtainable by the oxidation of artificial alizarin. By chemical agency the essential ingredients of madder are thus now produced in a cheaper, more convenient, and more effective form than it was formerly possible to extract them from the cultivated root. Madder extract, garancin, and alizarin dye heavier and more brilliant colours than madder, and they require less soaping or other treatment to clean the whites after dyeing. Madder extract and artificial alizarin are also used as steam colours.

We may now briefly follow the stages in printing a madder style, taking for example a calico printed in four 'colours' (the technical name for whatever is printed by the machine, whether mordant or dye), with a padding or blotch of weak iron liquor. In this case the mordants or colours are—

Black from strong solution of iron liquor.
Purple from weak solution of iron liquor.
Red from solution of red liquor.
White resist of solution of citric acid (lime juice).
Purple pad or cover of weak iron liquor, which falling on the acid resist forms a soluble ferric citrate.

Drying.—The cloth after receiving these impressions passes into a drying apparatus, generally a closed chamber, highly heated by radiation from steam-chests of cast-iron. Through such a chamber the cloth passes up and down over numerous rollers, traversing a long distance before it emerges dry and ready for the next process. Another means of drying, employed in some of the best establishments, such as Thornliebank, is by passing the cloth round a long series of revolving steam cans or cylinders, the metallic surface of which is covered with felt. Recently a most effective system of drying has been introduced, which consists of forcing a strong current of heated air through an enclosed chamber by the action of a fan, connected with which is an apparatus filled with pipes, through which the air passes, while surrounding the pipes is a steam space. By this plan any temperature may be obtained, and the current of air adjusted by the speed of the fan.

Ageing.—From the drying apparatus the goods pass to the ageing room, a lofty and spacious chamber (fig. 4), where they are exposed to the combined influence of heat and steam. The pieces pass, as shown by the arrows, up and down over rollers from end to end of the room, travelling over a long space, for twenty minutes or thereby. The atmosphere is rendered moist by jets of steam blowing from pipes *a*, *a*, and hot by radiation from the same and other steam pipes. A difference of four degrees is maintained between the dry and wet thermometers; the readings average 80° and 76° Fahr. The cloth takes up about 5 per cent. of its weight of moisture in its passage, and as it issues at the further end of the apartment, it is piled up in loose bundles, and so left for two or three days in a warm moist atmosphere. The object of the operation of ageing is to precipitate the mordants in the fibre of the cloth, they in the meantime being partly decomposed with the disengagement of abundant fumes of acetic acid. The practical development of the modern process of ageing is due to the scientific ingenuity of the late Mr Walter Crum of Thornliebank, the method previously practised having been tedious and uncertain, depending upon variable states of the weather.

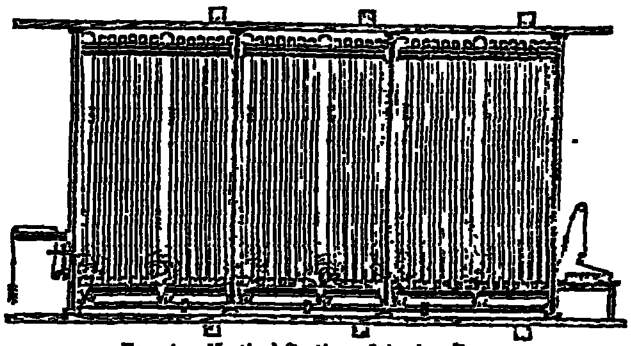


Fig. 4.—Vertical Section of Ageing Room.

Dunging.—It is next necessary to remove any superfluous uncombined mordant which may be on the cloth, and to take away the thickening agent with which the mordant was printed. These objects are accomplished by passing the goods through hot water, in which it was formerly the practice to dissolve cow's dung, hence the name; but now some of the numerous dung substitutes are chiefly used, the principal of which are the silicate and the arseniate of soda. The first operation in dunging is to pass the pieces through the "fly dunging" apparatus,—a cast-iron trough with rollers top and bottom,—by which the cloth is made to pass, in the open state, through the hot solution. This operation fixes the mordant in the fibre and prevents it from spreading to unmordanted parts of the cloth in the subsequent washing and dyeing operations to which it is subjected. Immediately after the fly-dunging the goods are washed and submitted to a second dunging, this time in a different kind of apparatus, through which they are passed in a coil or loose rope form. They are then thoroughly washed at a machine to remove the last traces of thickening matter and all uncombined ingredients.

Dyeing.—At this point the goods are ready for dyeing, the most important process in the whole series of operations. The dye-beck or vat, one form of which is shown in longitudinal and transverse section in fig. 5, consists of

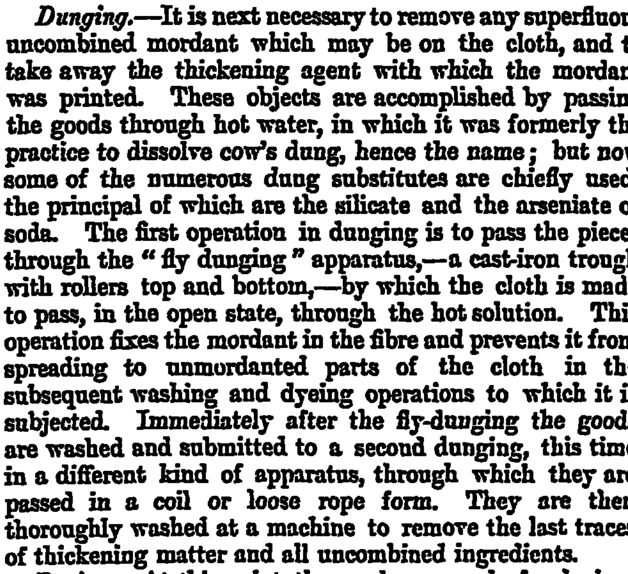


Fig. 5.—Sections of Dye Vat.

an iron cistern or trough A, into which the dyeing solution is introduced. Running along the whole length of the

trough is a steam pipe *b*, perforated at intervals, by which the requisite heat for the dyeing operation is raised and maintained. Sloping upward from the steam pipe is a perforated diaphragm of iron or midfeather *c*, and mounted on a strong framework over the trough is the winch D, which by its revolutions, effected by spur wheels, keeps the cloth moving down and up continuously into and out of the trough. A peg rail *e* runs along the length of the trough, which keeps the pieces from becoming entangled in their course. The figure shows the course of a chain of pieces being dyed on the endless system, in which about twenty-five pieces are sewn together, and passed in a spiral form up and down from end to end and back again, to go over the same course continuously throughout the entire time necessary for completing the operation. Another and more common method of arranging the pieces in the dye-vat is to pass two pieces, tied together end to end, over the winch between each separate pair of pegs, in which case the pieces revolve between the same pegs throughout the operation. Whichever method is followed, the operation and results are precisely the same. The required quantity of cold water is admitted into the trough, the pieces are arranged on the winch, the dye-stuff is introduced, and the machinery set in motion. Steam is then turned on, and the liquid is heated gently and gradually till it reaches about 180° Fahr. The process is continued for from an hour and a quarter to about two hours, during which time great care is taken to maintain the temperature arrived at, and to keep the pieces in constant circulation in and out of the vat. On the completion of the operation steam is shut off, and the pieces are rinsed through cold water, after which they are carefully and repeatedly washed. Fig. 6 presents a sectional view of an apparatus devised by Messrs Mather and Platt for loose washing after dyeing.

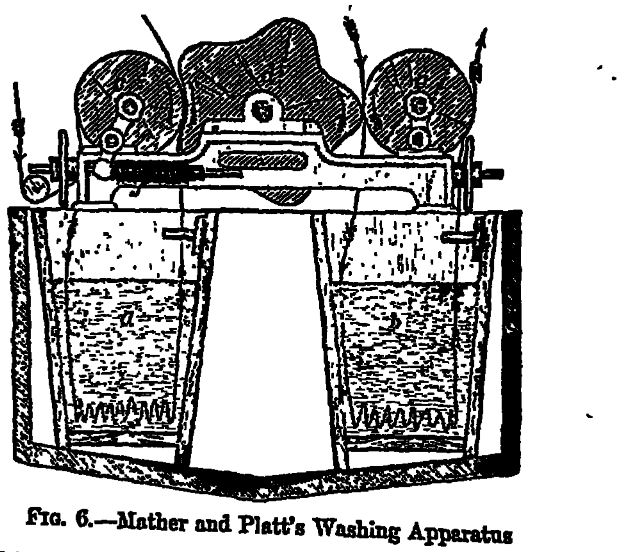


FIG. 6.—Mather and Platt's Washing Apparatus

In this machine there are two water-boxes *a*, *b*, and three bowls *c*, *d*, *e*, which are mounted horizontally in relation to each other. The central large bowl *d*, instead of being circular, has an irregular curved outline of alternate elevations and depressions. Against this irregular-shaped bowl the two side bowls *c* and *e* are made to press, and they move back and forward, following the irregular outline, pressed by powerful springs *f* acting on the axes on which they are mounted. They have thus a rubbing action in addition to their motion of revolution, an arrangement which produces a kind of flapping and squeezing action analagous to hand-washing.

Clearing.—At this point the dyed calicoes present a very unpromising appearance, the mordanted portions which have absorbed the dye being dull and heavy in colour, while the whites have a sickly pink aspect. The operations of clearing are necessary to remove all the dye-stuff which is loosely attached to the whites, and to develop and brighten the tints of dyed pattern. A variety of processes are pursued to accomplish this object, but in all the action of soap and some "chemick" or chlorine solution plays the principal part. The soap used must be free from all excess of alkali, and besides its detergent action it is supposed to be decomposed and give up part of its fatty acid to the lake formed by the mordant and the dye-stuff. The processes for clearing such calicoes as here described are as follows. After washing out of the dye-beck the goods are passed into a soaping beck, very similar in construction to the dye-beck, but surmounted with a pair of squeezing rollers instead of the winch of the dyeing apparatus. In this they are treated with a hot solution of soap; they are then washed out, squeezed, and again soaped,—the second time at a higher temperature than the first. After another washing they are "chemicked" in a weak chlorine solution, prepared by mixing chloride of lime with soda ash, with excess of soda, and from that a final washing in pure water should leave the goods clear and bright, ready for the finishing operations they receive in common with all other styles.

The reds and pinks produced by an alumina mordant with madder or artificial alizarin receive a different treatment. Mr Charles Dreyfus of Manchester, in a paper of great practical value communicated to the Society for the Promotion of Scientific Industry,[1] says of these colours: "They were some time ago dried and steamed; by the steaming a further quantity of colouring matter was combined to the mordant, and the shades thus obtained were fuller than if the goods had not been steamed. Now, instead of steaming only, the goods are passed through preparations the basis of which are fatty acids or fatty or resinous compounds; they are steamed after this preparation. I can speak highly of the good results obtained with some of these preparations, both as regards shade and saving of colour. The only difficulty is to obtain a good white; this can be overcome by careful and proper treatment of the goods. For reds and pinks there is a special and extra operation, commonly called the 'cutting.' It consists in passing the goods soaped and well washed through diluted nitromuriate of tin; the reds and pinks seem to be destroyed, becoming of a deep orange, but the subsequent soaping brings out again the brilliancy of the shade."

The processes above described are followed, with only modifications as to strength of mordants and the clearing operations, for the printing of calicoes with the madder preparations,—garancin, garanceux, and alizarin. The colours produced by these substances are as brilliant as madder colours, but they do not possess such fastness. On the other hand, the whites are not deeply stained in the dye-beck, and they generally require only a simple padding through a weak chlorine solution, and washing to clear the whites and prepare the goods for finishing. Some garancin and alizarin shades stand soaping well, and are improved in tone by such a treatment. Artificial alizarin and madder extract are now however chiefly used as steam colours, and to such perfection has printing in that style attained that the dye-house has been abandoned altogether in certain Continental establishments. The retention of dye-colour printing may now indeed be looked on as a question of comparative expense, which is determined chiefly by the price of fuel.

Turkey Red.—The production of this beautiful colour belongs rather to the province of Dyeing than to calico-printing; but as patterns are produced on it by means of discharges, it is necessary to include a notice of it under the head of dye colours. It is obtained with madder,

[1] Journal of the Society, vol. i. No. 3, Dec. 1874.

garancin, and both natural and artificial alizarin, but the pieces previously to being dyed have to undergo a long series of operations, which consist in passing them successively in olive oil and carbonate of soda, and hanging them in the air between the processes. They are then passed into a weak solution of red mordant, and afterwards of gall-nuts or sumach, well washed, and dyed in madder. When this has been effected, the colours are brightened by being boiled under pressure in a solution of soap and chloride of tin. On cloth so prepared certain discharge mixtures, principally tartaric acid properly thickened, are printed, and the pieces are passed through a solution of chloride of lime which removes the red, leaving a white pattern on a red ground. If a mineral colour or mordant is printed with the discharge it is left on the cloth in place of the discharged Turkey red, and thus various shades are produced in the brilliant red ground In bandanna printing the Turkey red calico is folded between metallic plates, which are perforated with designs, and so arranged that each figure of the design corresponds through the pile of prints so folded. The whole is then submitted to pressure, and a chlorine liquor is forced by pressure to percolate through the mass, which destroys the red colour in all those parts where the perforated plates allow the bleaching liquor to circulate.

Although madder and its various derivatives are the principal dye colours, there are various others which may be and sometimes are so treated. Of these the most important is logwood, the wood of *Hæmatoxylon campechianum*, which, although chiefly used as an oxidation colour, also yields with alumina and iron mordants black and sombre slate tints, which, however, do not possess the peculiar fastness of madders. Sapanwood and peachwood are also used as dye colours, the mordant and method of dyeing being the same as for madder or garancin; the cloth, however, does not receive the same treatment after dyeing, and does not require it, because these colours are much more easily removed from the parts of the cloth which are destitute of mordant. Beautiful reds and pinks are produced by means of cochineal; but this dye-stuff is chiefly used as a steam colour and for mousselines de laine. The mordant in the case of calicoes is either alumina or oxides of tin, and the method of proceeding is similar to that already described for madder and garancin colours. Quercitron bark (*Quercus tinctoria*), and flavin—a preparation from it, fustic, the wood of *Maclura tinctoria*, and Persian berries, the fruit of *Rhamnus infectorius*, are all used as dye colours, chiefly for the production of various shades of yellow In the paper above quoted, Mr C. Dreyfus states that mahogany has lately been brought out as a colour-giving substance, that it gives with the tin and alumina mordants very bright and fast shades of brown, much more brilliant than those made from catechu, and that he has dyed some very good specimens with Spanish mahogany.

Oxidation Colours.

Under this head is included a class of tinctorial substances which attach themselves to cotton fibre without the intervention of any mordant, but which for the development and fixation of their colour must undergo a process of oxidation after printing in the machine. The oxidation may be induced either by exposure of the pieces to atmospheric influences, by passing them through a solution containing an oxidizing agent, or by printing with the material some chemical substance which on exposure to heat gives off oxygen. The materials principally treated in this manner are indigo, catechu, aniline black, and certain blacks obtained from logwood. The processes adopted for the printing of indigo and aniline black—the two most important styles under this head—will make the practical application of the oxidation principle clear.

Indigotin, the colouring principle of indigo, is a substance obtainable from several other plants besides the species of *Indigofera*, from which it is commercially prepared. It is a body altogether insoluble in water, alcohol, ether, oils, or dilute acids or alkalies; but in presence of a variety of substances it takes up an additional equivalent of hydrogen, and thus is converted into white indigo, a colourless substance soluble in solutions of alkalies and alkaline earths. The change is thus represented.

$$\underset{\text{Indigotin}}{2(C_8H_5NO)} + \underset{\text{Hydrogen}}{2H} = \underset{\text{White Indigo}}{C_{16}H_{12}N_2O_2}.$$

White indigo is a most unstable compound, taking up oxygen with great facility either from the air or from certain solutions, and thus becoming retransformed into blue indigo. Advantage is taken of these circumstances in printing indigo colours; the colour is hydrogenized and dissolved, in which condition it is applied to calico, and on exposure of the pieces so dyed to the influence of oxygen the blue colour is both developed and fixed in the fibre. The following are the principal styles in practice:—

Indigo-blue dips.—This fine blue colour is produced in the old copperas vat method by putting in a vat holding 2000 gals. of water 60 ℔ of finely ground indigo, to which is gradually added 120 ℔ of green copperas, or sulphate of protoxide of iron, together with 180 ℔ of slaked lime. Owing to the lime removing the sulphuric acid from the salt of iron, the protoxide of that metal is liberated, and by its affinity for oxygen it decomposes the water, liberating hydrogen, which in its nascent condition reacts on the blue indigo, and thus transforms it into white indigo, which is soluble in the excess of lime employed in the operation. A zinc vat of recent introduction is now much more generally adopted than the above, its advantages being that the indigo is much more quickly converted, and by avoiding the abundant precipitate of sulphate of lime a better class of work is produced. The zinc vat is prepared by adding to the 2000 gals. of water 20 ℔ of ground indigo, 30 ℔ of iron filings, 30 ℔ of finely powdered zinc, and 35 ℔ of lime. The powdered zinc in presence of the lime decomposes the water, giving off hydrogen, which is taken up by the indigo, which then as white indigo dissolves in the lime.

By whichever process prepared, the dye-vat being ready, a piece of calico is hooked on a wooden frame and well stretched out; it is then dipped into the vat for fifteen minutes, taken out, and left exposed to the air for five minutes. The piece of calico, which is white when it comes out of the vat, gradually becomes green and then blue, owing to the oxygen of the air oxidizing the white indigo, and transforming it into blue, which is insoluble in water and fixed on the calico. The number of successive dips that the piece undergoes varies according to the various shades of blue which the printer requires. The pieces, after having been passed into a weak solution of sulphuric acid or "sours," which fixes the indigo thoroughly, only require to be well washed and dried.

To produce the well-known style of print which consists in a blue ground and white design, it is necessary to print a resist, pass the pieces into a vat containing lime, and then dye them in the above indigo vat. The principal resist used is the *blue resist*, a mixture of sulphate, acetate, and sometimes nitrate of copper, and the solution is thickened with British gum, or calcined flummery, together with pipe-clay for the block, and flour for the machine printing. When the cloth on which this paste has been printed is dipped into an indigo vat, the indigo is oxidized before it reaches the surface of the cloth. After

dyeing, the pieces are passed through weak sulphuric acid, not only to remove the oxide of copper, which has been precipitated, but also to fix the indigo on the calico, by liberating it entirely from its lime combination. Various other resist pastes are employed when it is desired to print other colours over the white portions, as for example, when orange or yellow grounds are desired the mixture consists of a salt of copper to resist the blue indigo vat, with a salt of lead to produce the chromate of lead by treatment with bichromate of potash after the blue dyeing is complete. The late J. Lightfoot of Accrington devised and patented, in 1867, a method of printing reduced indigo simultaneously with the mordants for madder, garancin, and other dye colours, by which a combination of indigo blue with other tints can be obtained of perfect clearness and brilliancy, without resorting to the complex and tedious processes involved in discharging colours, repeated printings, &c., when colours are blocked on a blue ground. The success of his process depends on the preparation of a pulp of indigotin and tin, in which he carefully avoided any excess of tin salt, so that it does not attract the alizarin in the madder beck, and in consequence leaves the indigo effects clear and unclouded.

China Blue.—This style of print is obtained by printing on the calico a mixture composed of pulverized indigo and sulphate of protoxide of iron, to which is sometimes added orpiment, and thickened with British gum. The pieces so printed are passed alternately, by means of rollers, first into a milk of lime, and then into a solution of sulphate of protoxide of iron, when there ensues one of the most interesting phenomena of calico-printing; for as fast as the blue indigo is reduced into white indigo, instead of being dissolved by the lime of the bath, it is retained with force through the molecular attraction of the fibre of the calico, and prevented leaving the cloth until it is fixed by the exposure of the piece to the oxygen of the atmosphere. The pieces then only require to be passed into weak sulphuric acid, washed, and dried, in order to be completed. This process is not now much used.

Pencil Blue is obtained by reducing blue into white indigo, by boiling it for several hours with protochloride of tin and alkali. When the indigo is well reduced, citrate of soda and starch are added; and after the whole is carried to the boiling-point, the calico is printed with it, passed into a milk of lime, washed, and dried.

Aniline Black is a most beautiful and fast colour, prepared by mixing a salt of aniline with a metallic salt and an oxidizing agent, which substances on exposure gradually react on each other, and develop a rich velvety black. There is thus produced one of the most unalterable colours known, resisting soap, acids, and even chlorine to a remarkable extent. It is a colour of recent introduction, having been first printed by Mr John Lightfoot of Accrington, in 1859, and patented in 1863; but it is now in very extensive use, many different methods for producing it having been devised and patented. The most extensively employed system is that patented in 1871 by Mr Lightfoot, the originator of the colour, which is thus given by Mr Dreyfus—30 pints chlorate of ammonia, prepared either by means of tartaric acid and chlorate of potash, or by another process without tartaric acid, are thickened with 6 to 8 ℔ wheat starch and 6 to 8 ℔ best dark British gum. When this colour has been well boiled, it is allowed to get cool, and then 7 pints of a solution of the purest and most neutral aniline salt that it is possible to get are added; this solution is made with 8 ℔ of salt to the gallon of water, with three-quarters to one pint of sulphide of copper paste. After the mixture is printed, the pieces are lightly dried and hung in the ageing room in a moist warm atmosphere, with the dry bulb thermometer about 80° and the wet bulb 10° lower. From thirty hours to two days are required to develop the colour, the printer judging of the progress of the ageing by the tint. According to Mr William Mather an ordinary ageing machine will effectually "age" the aniline black, if only a proper current of air is maintained of the requisite moisture and temperature. This is readily accomplished by having a properly contrived outlet to the chamber at the top, the draught of which is controllable, and inlets for fresh air in the sides of the chamber. This mode Mr Mather states is in successful operation, and by simple mechanical contrivances may be universally adopted. When the pattern has assumed a deep bottle-green tint, the goods are removed and passed through a solution either of bichromate of potash, of carbonate of soda, or of both mixed, and then soaped and dried. When aniline blacks are to be further printed with steam colours or dye colours, as is commonly the case, the treatment of the pieces after ageing is modified according to the necessities of the case.

Chrome Black is an oxidation colour produced by printing with logwood liquor and passing the goods through a bath of bichromate of potash, when the colouring principle of the logwood—hæmatoxylin—undergoes a special oxidation. The colours obtained from catechu are also fixed by oxidation, the colouring principle—catechuin—being only soluble in its unoxidized condition, and when oxidized after printing, it yields various browns and drabs, which have a very high degree of fastness.

Steam Colours.

The various processes of printing included under this head are of modern introduction, but they have steadily risen in importance, till now they embrace the largest part of the art, having so largely and rapidly superseded all other styles that the process would appear to be destined to become the predominant style of the future. Indeed, to such perfection have steam colours been brought that in some Continental establishments, it appears, the dye-house has been altogether closed and steam colours only now printed. As compared with the printing of dye colours the "topical" or steam colour style is simple, direct, and expeditious, requiring no tedious dyeing, and only light soaping, clearing, and finishing operations. By the dyeing processes alone the range of shades which it is practicable to print on one piece is strictly limited by what the mordants and their various combinations will yield with the particular dye-stuff used. But in steam colours there is no limit to the number and variety of shades which may be produced, each colour-box on the cylinder printing-machine containing the whole ingredients essential to the production and fixation of a separate and distinct shade or colour. In addition to this the steaming process can be and is extensively employed to supplement the effect of madder-printed or Turkey red goods by printing steam colours into the whites, produced either by resist pastes or by discharges printed on the dyed texture.

The distinguishing peculiarities of steam colours consist—1st, in printing direct and at one operation on the cloth the whole of the materials of the dye and its fixing agent properly mixed and thickened; and 2d, in submitting the printed cloth to the influence of steam, which effects the fixation of the colour. The effect produced by the combined heat and moisture of the steaming process is, in the case of certain combinations, purely mechanical, while in others a chemical reaction ensues. In the printing of what are termed pigment colours, or, in other words, insoluble coloured powders such as used by painters, they are simply mechanically fastened or glued to the cloth by means of albumen, or some body of similar constitution, which coagulates and becomes insoluble on the application of a

certain heat. In the case of the regular steam colours and aniline dyes there is printed on the cloth a chemical mixture or solution, which on the application of heat produces a reaction resulting in the precipitation of an insoluble compound in the fibres, or a volatilization of the solvent medium is caused, so that in both cases the same result—an insoluble precipitate—is produced.

With the development of steam colours efforts have been made with success to improve on the original crude and unsatisfactory manner in which the steaming was performed. The old method, still largely employed, consists in wrapping the printed cloth around a perforated cylinder of copper, called a "column," into one end of which a pipe passes for the admission of steam. Around the column are first wrapped several folds of felt, above which comes white calico, next the printed goods, and lastly an outer envelope of white calico. When so prepared the column is set perpendicularly on a steam pipe, a stop cock is opened, and steam is admitted into the interior of the column, which presses through and acts on the printed goods. Immediately on the conclusion of the process the column must be dismounted and the goods run off, otherwise steam might condense in the cloth and cause certain colours to run.

The most common arrangement for steaming, however, consists of the chest or "cottage," which is a cylindrical steam-tight chamber, into which a carriage is introduced. The carriage is mounted with a series of rollers on which the pieces to be steamed are hung, or, in a different arrangement, the cloth is fastened on a range of hooks projecting from a steam pipe. In the latter arrangement the hooks are heated by steam before the carriage is thrust into the chest, to prevent condensation of steam on the cold spikes, and consequent rust-staining of the cloth. Fig. 7 shows a

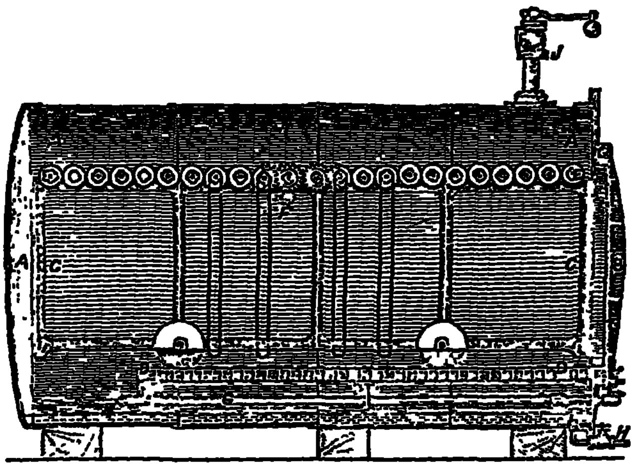


Fig. 7.—Section of Steaming Chest.

sectional view of an ordinary steaming chest by Messrs Mather and Platt. A represents the body of the chest; B the steam-tight door, which draws up when the chamber is to be opened; C the carriage or waggon fitted with a range of square wooden rollers E. The rollers are all geared to move by means of a cog-wheel F, which is turned by the attendant outside the chamber. The carriage is run in upon the rails D; steam is admitted by the perforated steam-pipe G; H is a tap for running off condensed water, and J is a safety-valve. While one carriage is in the chamber another is being filled and prepared outside to take its place when the goods are sufficiently steamed.

The steaming chest is at best only a crude and disconnected manner of performing one process in printing, and as all the others are continuous, it forms an awkward break in the series. To obviate this, and to secure expedition and continuity, a method of steaming has been devised by M. Cordillot of Moscow and Mr William Mather of Salford, which they patented in 1874. Their apparatus, of which a sectional illustration is shown in fig. 8, they claim will effectually steam 1000 pieces of 25 yards per

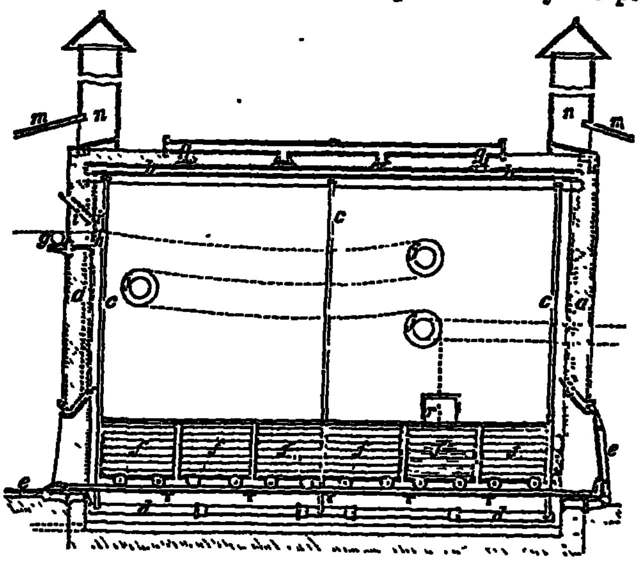


Fig. 8.—Cordillot and Mather's Steaming Apparatus.

day. According to their specification, it consists of "a brick or other chamber *a*, the roof of which is lined with a curved steam jacket *b*, connected by side pipes *c c* to the perforated pipe *d* near the floor. At each end of the chamber *a* is an opening closed by a steam-tight door *e*, through which openings the waggons for receiving the steamed fabrics are admitted and discharged. The fabric is fed into the chamber *a* over the feed roller *g* and between the small guide roller or tube *h* and copper troughs *i* and *i*, both of which and the tube *h* are heated by steam and project on each side of the wall to collect any moisture that may run down. When the fabric is in the chamber it is carried around three or other convenient number of rollers marked *j*, the last of which delivers it into one of the waggons *f*." The rollers are all heated by steam to prevent condensation, and as very moist steam is required for some colours, the supply pipe passes through water before entering through the pipes *q* into the curved jacket *b*, and thence going by the side pipes *c c* into the perforated pipe *d* as before described. "When the apparatus is in operation the steamed fabrics are deposited in one of the waggons, as shown in the figure, and when one is full both end doors are opened to allow the last waggon near the left-hand door to be discharged and to move the full waggon one step towards the exit door by the introduction of an empty waggon through the right-hand door; this brings another waggon in position for receiving the steamed fabrics, and while this is being filled the full waggon (after the four empty ones introduced to fill up the chamber at starting have passed through) that had been discharged can be emptied and brought back to the entrance door." The waggons are made of strong wire and are heated up before entering the chamber. By this system the patentees affirm that the goods are long enough exposed to the steam to allow the chemical reactions to take place in the cloth, so that the colours neither print off nor run during the remainder of the process, and the fixation is completed while the goods lie in the waggons inside the chamber. This system of steaming is in successful operation in some Manchester print-works.

Steam colours include two distinct classes of work—1st, pigment colours, or the series fixed by a mechanical effect produced in steaming; and 2d, ordinary steam colours, in which the fixation is effected more by chemical agency.

Pigment Colours are so named because the tinctorial agents employed are coloured lakes, and the insoluble mineral powders used otherwise as painters' colours. Only a limited number of painters' colours are so used, as, for a variety of reasons, many of them are not suitable for calico-printing. Colours containing arsenic, for example, and some others which produce brilliant effects, cannot be used on account of their highly poisonous nature. Others are excluded on account of their cost, some are too dull and muddy in colour, and some are liable to tarnish or darken on exposure to light, air, moisture, or other influences. The pigments which are most extensively useful are ultramarine blue, Guignet's or chrome green, and chrome orange, all of which are very largely used by themselves or in combination with other colours. Lamp black is also employed for the production of a solid grey, and vermilion-red with some other metallic sulphides are sometimes, though rarely, printed as pigment colours. The principal lakes used are carmine, corallin lake (a derivative of phenol or carbolic acid), black logwood lake, and several others prepared from the dye-woods with tin and alumina salts. The aniline dyes on their first introduction were also worked as pigment colours, and printed with albumen.

The first medium employed for fixing mineral pigments and lakes to calico was a solution of India rubber in coal naphtha, an agent which, so far as clearness and permanency of the printed colour is concerned, was perfectly satisfactory. The steaming dissipated the highly volatile naphtha and left the thin film of caoutchouc mixed with the colour firmly adherent to the tissue. But the inflammability of the copious naphtha fumes evolved gave rise to many serious accidents, and the method had on that account to be abandoned. No other medium has been found to give so satisfactory results as the protein compounds, of which albumen obtained from the white of eggs is the type. Besides egg albumen, blood albumen, lactarin or casein from milk, and gluten from wheaten flour are used as agents for fixing pigments. In printing with albumen advantage is taken of its well-known peculiarity of coagulating and becoming quite insoluble at a temperature under the boiling point. It is mixed with the colour and deposited on the cloth in its soluble state, when, by the operation of steaming, it coagulates and remains firmly attached to the tissue, imprisoning with it the particles of colour with which it was mixed. The cloth is not in reality dyed, but has only a coloured pattern mechanically fastened or glued to it. Egg albumen gives the most delicate and clear shades, but recent improvements in the preparation of blood albumen render it increasingly available for bright colours. Lactarin and gluten, dissolved by means of caustic alkalies, are used for printing ultramarine and other pigment colours. The length of time that pigment colours are left in the steaming apparatus varies from half-an-hour to an hour.

Ordinary Steam Colours.—The essential features of this style consist in printing direct on the cloth the dyeing material, mixed in proper proportion, with any necessary mordant, and certain acids or salts to keep the mixture in solution. On the application of moist heat after printing, the acid is evaporated or a chemical decomposition takes place in the case of the salt, and an insoluble precipitate is produced in the fibre. Steam colours possess great brilliancy, but they have not the fastness and solidity of madder-dyed goods. The dyes in the case of steam colours must be in the form of decoctions or prepared extracts of the special chemical tinctorial principles. Such preparations have of recent years come into very wide use, and with the progress of chemical science they are daily attaining greater prominence and perfection, so that the older application of crude materials is rapidly being supplanted by the use of agents of known strength and quality. Thus, as already mentioned, madder extract and artificial alizarin, treated as steam or "topical" colours, have largely taken the place of madder root as a dye colour, and by the preparation of artificial alizarin from anthracene, printers are now rendered independent of the vegetable kingdom as a source of their hitherto most important dye-stuff.

As a preparatory to printing, the cloth is mordanted or prepared by passing it through a solution of stannate of soda, and treating with a very weak solution of sulphuric acid which decomposes the stannate, combining with the soda, and leaves the stannic acid (peroxide of tin) precipitated in the fibres. Cloth thus prepared has much purer and brighter shades than simple bleached calico. The common steam colours include black and chocolate from logwood liquor, orange from annatto, yellow from Persian berry liquor and from bark liquor, green from Persian berries and yellow prussiate of potash, purple from logwood and red prussiate of potash, dark red from sapanwood and bark liquor, reds, purples, and chocolate from madder extract and alizarin, and blues from Prussian blue. Iron, alumina, and other mordants are used with these colours according to their character and the nature of the shades desired. The solvent principally employed is acetic acid, which readily volatilizes in the steaming process, but oxalic acid is also employed to keep certain special oxides in solution during the printing. Oxidizing agents, as the chlorate or bichromate of potash, are also required for the development of some colours. Steam blue is printed, not by using the Prussian blue colours ready formed, but by effecting the chemical reaction on the cloth itself, which results in the blue colour. In some cases yellow prussiate of potash is used, which yields Prussian blue; again, when the red prussiate is employed, Turnbull blue is the result; but a mixture of both, to which a proportion of ferro-prussiate of tin, called tin pulp, is added, is the source of the best steam blue. The reaction by which the colour is developed will be understood by instancing the development of Prussian blue from the yellow prussiate. It is mixed with an acid—tartaric, oxalic, or sulphuric—or the whole three combined, and printed on the cloth. In the steaming the added acid combines with the potassium of the prussiate and liberates ferrocyanic acid, which is further decomposed into cyanide of iron, abundant fumes of hydrocyanic acid (prussic acid) being meantime evolved. On withdrawing the goods from the steaming chest after this decomposition is complete the pieces are quite colourless, but exposure to the atmosphere in an ageing chamber, or passing them through an oxidizing solution, such as the bichromate of potash, develops the characteristic blue of Prussian blue.

Aniline Colours.—These colours now constitute the largest and most important section of steam-fixed dyeing materials, and in their behaviour and method of printing they form a class by themselves. The range of aniline colours now embraces almost every possible shade; and in no other department of scientific and technical research has equal activity been displayed within the few years which have passed since these colours were introduced; and the rewards of investigation have been commensurate. The number of colours introduced, and the methods of preparing them which have been suggested are beyond computation, and the list of those which are now in current use is exceedingly extensive. In addition to the dyes procured from aniline many more of an allied nature are prepared from other derivatives of coal-tar, phenol, naphthalin, and anthracene, some of which have also come into extensive use, and the applicability of others has been demonstrated. The topical use of these colours in connection with extract of madder, Guignet's green, ultramarine, &c., has exercised a powerful influence in improving the art of design in con-

nection with calico-printing, placing as they do at the disposal of the designer an unlimited range of the most striking, brilliant, and pure colours.

Aniline colours have a powerful affinity for animal substances, dyeing silk and woollen tissues readily without the intervention of any mordant. Taking advantage of this property aniline colours were, on their introduction, printed as dye colours, albumen being used as a mordant. An albuminous solution was printed and fixed on the cotton, and on its introduction, so prepared, into the dye-vat the albumen readily took up the colour, while the unmordanted portions merely imbibed an easily discharged stain. Aniline colours were also printed with albumen in the manner already described as applied to pigments and coloured lakes; and the patents secured by Mr Walter Crum, in 1859, for the application of gluten and lactarin in printing, had reference chiefly to the use of aniline colours. The process of fixing these colours now generally adopted is known as the arsenite of alumina process. In this process the dye is dissolved in water or acetic acid, carefully filtered through a fine cloth and mixed with acetate of alumina, a thickener, and arsenious acid dissolved in glycerine. This mixture is printed on the cloth, which is then introduced into the steaming chest. In the steaming, acetic acid is liberated and arsenite of alumina formed, which with the aniline colour is precipitated in the fibres as a brilliant insoluble lake.

Spirit Colours.

This style of printing consists simply of a modification of the process for ordinary steam colours, but excluding the steaming. All the decoctions and extracts used for regular steam colours may be employed in this method, but they are mixed with such large proportions of the mordants and acids that were they submitted to the action of steam the fibre would be quite destroyed. When printed, spirit colours are therefore simply dried and aged for several hours, after which they are rinsed in water, washed, and dried. The style yields very brilliant but very loose and fugitive colours, and is now falling into disrepute.

Finishing Processes.

After the prints have undergone the various operations described above, they are submitted to a series of processes, whose object is to give to the fabrics such an appearance as will please the eye of the buyer. All the finishing processes have one common end, namely, to fill up the interstices which exist in the fabrics, and thus give to the calico a more substantial and glossy appearance; and this is effected by filling the cloth with boiled starch, farina, or sour flour, which is obtained from wheat flour which has been allowed to ferment. To these are ofter added large quantities of sulphate of lime or baryta, and other similar substances, with the object of imparting to the cloth a weight and appearance of solidity which it does not really possess. The finishing processes are varied according to the nature of the print, muslins requiring a quite distinct method of treatment from ordinary calicoes, and furniture chintzes also receive a finish peculiar to glazed goods. Some of the apparatus employed in finishing will be found figured under the heading Bleaching, where also the subject is entered into in some detail. As the general features of finishing, including water-mangling, drying, damping, starching, and calendering are the same both for white cottons and prints, it is unnecessary here to detail these operations. The machines and operations in a finishing-room may be briefly noticed as follows. The goods are opened by passing over a winch at a considerable elevation, and if necessary stretched in breadth on a machine which evens the texture and draws it out laterally. They are then passed into the chloring machine, which has two rollers, one of brass and one covered with india-rubber. The lower one is made to revolve in an aqueous solution of chlorine, and as the cloth passes between the rollers it is saturated with this solution. It passes immediately through a box containing a vapour of steam, which at once arrests the action of the chlorine, the momentary contact being considered sufficient to brighten the white ground without giving time for the colours to be affected. From the steaming box the piece passes through a water mangle, where pure water is spurted on the cloth, and after passing through the trough it receives a hard squeeze to extract as much moisture as possible before the drying is reached. The machine is a range of steam cans, generally made of copper. The next operation is that of starching, the machinery of which is almost identical with that used for chloring, starch paste, however, occupying the place of the chlorine liquor. The lower roller revolves in and carries up the starch to the cloth, which passes round the upper rollers and becomes saturated by the squeezing action produced and regulated by the screws and levers of the machine. After starching, the goods pass direct to another drying machine, whence they are taken to be damped by a slight sprinkling of water, which they receive in passing over a simple machine for the purpose, consisting of a rapidly revolving brush throwing up a fine spray. Calendering is the next and final operation, after which each piece is separated and folded up by a plaiting machine, or hooked by hand. It is then made up in the ordinary book form, and after being pressed in a screw or hydraulic press is ready for the market. (J. PA.)

CALICUT, or Kolikod, a seaport town of India on the western coast, in the British district of Malabar and the presidency of Madras, situated about 560 miles S. of Bombay, in 11 15′ N. lat. and 75° 52′ E. long. The town stands on the sea-shore in a low and unsheltered position; and as there is neither river nor harbour, ships are compelled to anchor in five or six fathoms water, about two or three miles from land The houses are for the most part built either of sun-dried brick or laterite, and have a tidy appearance. In the quarter of the Moplahs or Mapillas there are several mosques, and the Portuguese quarter possesses a Roman Catholic church One of the largest buildings is the jail, which can accommodate 600 prisoners. The port is frequented by vessels from the Red Sea and the Persian Gulf, which return with freights of rice, cocoanuts, ginger, cardamoms, sandal-wood, and teak. The weaving of cotton, for which the place was at one time so famous that its name became identified with its *calico*, is no longer of any importance. Calicut is of considerable antiquity; and about the 7th century it had its population largely increased by the immigration of the Moplahs, a fanatical race of Mahometans from Arabia, who entered enthusiastically into commercial life. It was the first place in India visited by any European navigator, for it was there that Vasco de Gama arrived in May 1498, ten months and two days after his departure from Lisbon. At that time it was a very flourishing city, and contained several stately buildings, among which was especially mentioned a Brahminical temple, not inferior to the largest monastery in Portugal. In 1509 the Marshal Don Fernando Continho made an unsuccessful attack on the city; and in the following year it was again assailed by Albuquerque with 3000 troops. On this occasion the palace was plundered and the town burnt; but the Portuguese were finally repulsed, and fled

to their ships after heavy loss. Not long after they concluded a peace with Prince Zamorin or Tamuri, and were allowed to build a fortified factory in the town. An English factory was founded in 1616. The town was taken in 1765 by Hyder Ali, who expelled all the merchants and factors, and destroyed the cocoa-nut trees, sandal-wood, and pepper vines, that the country, reduced to ruin, might present no temptation to the cupidity of Europeans. In 1782 the troops of Hyder were driven from Calicut by the British; but in 1789 it was taken and destroyed by his son Tippoo, who carried off the inhabitants to Beypore, and treated them with great cruelty. In the latter part of 1790 the country was occupied by the British; and under the treaty concluded in 1792, whereby Tippoo was deprived of half his dominions, Calicut fell to the British. After this event the inhabitants returned and rebuilt the town, which in 1800 consisted of 5000 houses. The present population is upwards of 25,000, composed largely of Moplahs, but including about 4000 or 5000 Portuguese, besides Parsees, English, &c.

CALIFORNIA

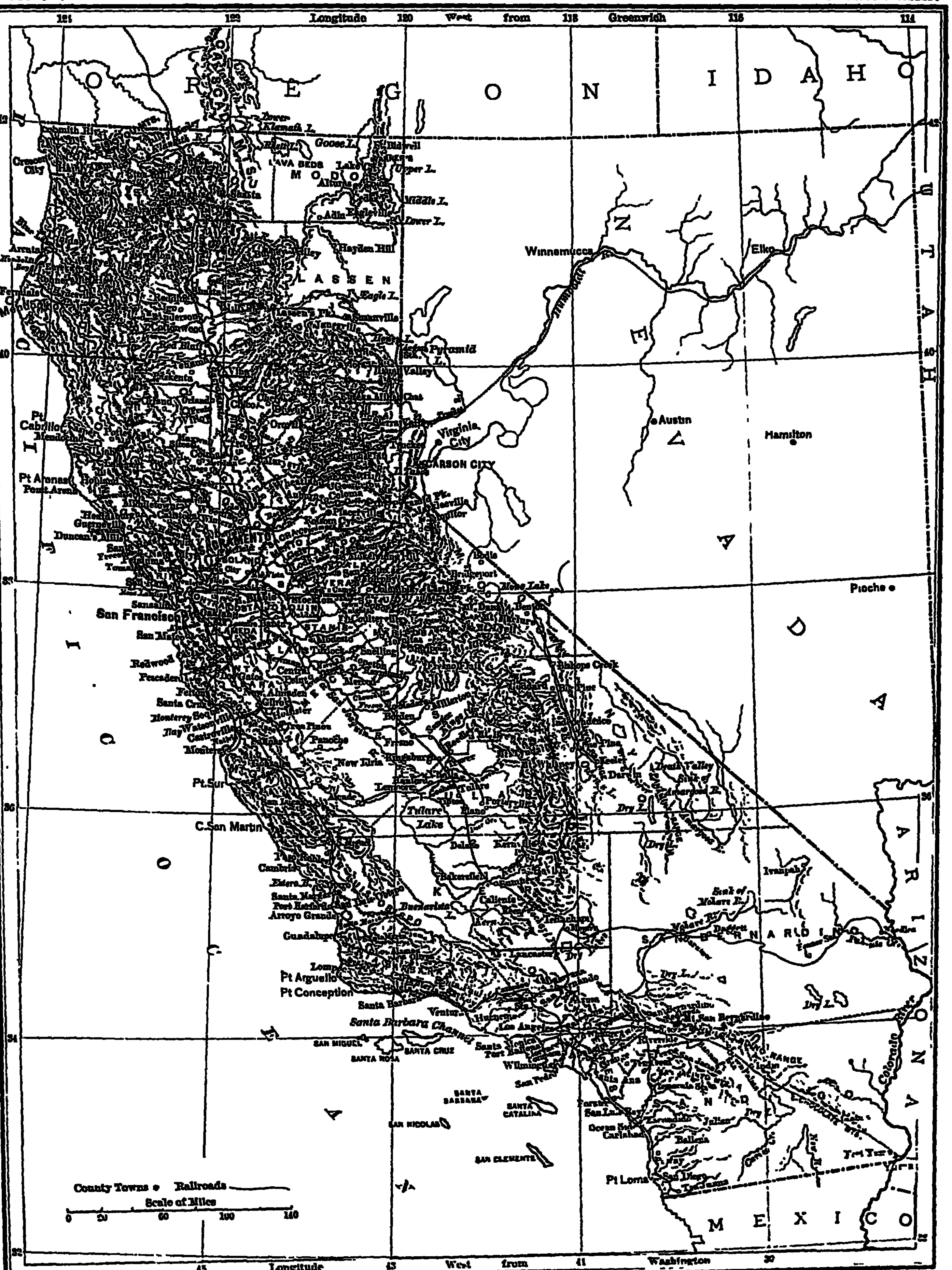
CALIFORNIA, the name originally given to a portion of the region of western North America bordering on the Pacific Ocean, and apparently taken from a Spanish romance (*Las Sergas de Esplandian*), in which the author speaks of "the great island of California, where a great abundance of gold and precious stones is found." This romance was published in 1510, and, becoming quite popular, the name of California probably struck the fancy of some one of the officers or companions of Cortez, and was applied by them to the newly-discovered country, perhaps on account of its association with a region fabulously rich in gold, the early Spanish discoverers in America always expecting to find an El Dorado in every new region they entered

As at first used, the name of California was applied to the coast and the territory at a little distance from it, north of Mexico; gradually it was extended over what we now call the "Great Basin," and with no well-defined limits to the north At the present time, the name California means only the State of California, one of the United States of America, and the peninsula is called Lower California. To the Spanish Americans these natural divisions of the country were and still are known as Upper and Lower California (Alta and Baja California), and the two were called "Las Californias"—the Californias.

The first discovery of the coast of Lower California was made in 1534, by an expedition sent out by Cortez, and consisting of two ships, commanded by Bezerra de Mendoza, and Hernando de Grijalva; and later, the gulf now known as the Gulf of California was discovered and navigated by Cortez himself; after whom it was for a time called El Mar de Cortez, and later El Mar Vermejo (the Red or Vermilion Sea), in consequence of the red colour which it has at times, and which is probably due to the multitudes of small animalculæ (crustaceans ?) inhabiting its waters. In 1540 the mouth of the Colorado River was discovered by Alarcon, in command of a fleet sent out by Mendoza for geographical exploration. In 1542 the coast of California proper was explored by Cabrillo as far north as Cape Mendocino, in latitude 40°30′. In 1578 Sir Francis Drake entered the Pacific, and coasted along the shores of the American continent, reaching a point as far north as 48°. Whether he discovered the bay and harbour of San Francisco has been and still is a matter of dispute. By some he is supposed to have tarried and refitted his ships at what is now known as Sir Francis Drake's Bay; by others he is believed to have done this in the Bay of San Francisco itself. The evidence seems to decidedly preponderate in favour of the first of these suppositions. In 1602 the bays of San Diego and Monterey were discovered by Viscaino; but more than a hundred and fifty years elapsed before the latter was visited again, and before settlements began to be made on the coast of Upper California. The peninsula (Lower California) was entered by Jesuit missionaries in 1697, and a permanent mission established at Loreto; where, and at other points, the Jesuits maintained themselves, on the whole successfully, until 1767, when they were expelled from the country by order of Charles III. of Spain, and all their property turned over to the Franciscan monks. Later, the Dominicans obtained exclusive possession of the peninsula; and the Franciscans, not unwillingly, withdrew to Upper California, where they established themselves, built numerous missions, and throve remarkably until Mexico became independent of Spain in 1822; this event was a death-blow to the establishments of the Franciscans, which from that time forward lost ground from year to year, and finally were broken up altogether in 1840. The treatment by the fathers of the natives of the country was successful so far as the accumulation of material wealth was concerned, but not in the slightest degree conducive to their intellectual advancement or development, as the so-called converts were simply the slaves of the "good fathers." The whole number of the mission establishments was twenty-one,—the first founded in 1769, the last in 1820. They were all on or near the coast or bay of San Francisco, and the fathers displayed most excellent judgment in selecting for their sites the very garden-spots of the country. The number of the aboriginal inhabitants of California has rapidly decreased within the past forty or fifty years. The various authorities agree in fixing their number at over 100,000 in 1823. In 1863, according to the census made by the Indian Department, there were only 29,000; the census of 1870 gave about the same results, namely, 29,025, 5784 being actually enumerated, and the remainder merely an estimate. It is certain that the decrease in the Indian population was at one time exceedingly rapid; it would appear, however, that at present it is much less so. The few that are left are mostly a degraded, miserable set of beings.

During the time of the flourishing of the missions of California, the connection of the country with Spain through Mexico was a very loose one. Gradually a trade of some importance sprang up between the Atlantic and Pacific sides of the continent. Boston had for a number of years an entire monopoly of this business, which consisted chiefly of an exchange of groceries and cotton goods for furs and hides. The voyage usually lasted two years or more, and the profits were large. A few Englishmen and Americans wandered into California from different parts of the world between 1810 and 1830; and some adventurous and daring men found their way across the continent, in the pursuit of the dangerous and exciting business of hunting and trapping. It is estimated that there were, in 1830, as many as 500 foreigners on the west side of the Sierra Nevada. Of all these early pioneers, John A. Sutter is the one who is best known, from the fact that the first effective discovery of gold, by the Americans, was made by men in his employ; and also on account of the generous hospitality with which he welcomed the first comers into California, notably Fremont and his party.

In 1842 Commodore Jones of the American navy captured the fort of Monterey, raised the stars and stripes, and took



ENCYCLOPÆDIA BRITANNICA NINTH EDITION

possession of the country for the United States; but the next day he hauled down his colours, and apologized for his mistake. About this time the attention of the United States Government began to be strongly attracted towards California; and, as is universally believed in that State, the French and the English were also looking in that direction, with a view to a future possible taking possession of the country All the circumstances connected with the seizing of California by the United States will probably never be known. It appears pretty clear, however, that the authorities at Washington, having determined on a war with Mexico, and fully aware of the importance to the United States of an extension of their territory on the Pacific, resolved to take possession of California, so that after the termination of the war, matters being settled on the basis of *uti possidetis*, that country would become a part of the United States. At all events, Fremont being accidentally engaged in conducting a scientific expedition on the Pacific coast, received in May 1846, verbal instructions from an officer dispatched from Washington in a national ship, and who had crossed from Vera Cruz to Mazatlan. In consequence of these instructions, he turned back, made his way at once to Sutter's Fort, then to Sonoma, where he organized a battalion of mounted riflemen; and on the 5th of July he called his forces together, and recommended a declaration of independence. On the 2d of the same month a United States frigate had arrived at Monterey, where, on the 7th, the commander hoisted the American flag, issuing at the same time a proclamation, in which California was declared to be, from that time forth, a portion of the United States. This was followed by some fighting with the native Californians, and much bitter discussion and dissension among the different officers of the navy and army, who were concerned in the conquest of the country. The principal result was, that Fremont, who was tried by court-martial, found guilty of mutiny, and sentenced to lose his commission, was ever afterwards considered by the people to have been the real conqueror of California; and, in consequence, he came near being elevated to the Presidency. The country was entirely pacified before June 1847; and in March 1848 a treaty was ratified between the Governments of the United States and Mexico, by which the whole of Upper California was ceded to the United States, just at the moment when the discovery of gold on the American River was beginning to attract attention; and when the news of the ratification reached the Pacific coast, the excitement had already spread far and wide; San Francisco was deserted, and the whole population of the country was at work in the mountains, digging gold. The discussion as to what should be done with California, when acquired, began in Congress in 1846; and the question of slavery or no slavery in the new territory was at once raised. A most furious conflict followed, and nothing was accomplished during that session or the next; even as late as the adjournment of Congress, on the 4th of March 1849, the only progress made towards creating a Government for the new territory, was that the United States revenue laws had been extended over it, and San Francisco made a port of entry. In consequence of this the people themselves got together in September 1849, and a constitution was framed forbidding slavery, and in other respects resembling the constitutions of the free American States On the 7th of September 1850, a bill finally passed Congress, admitting California into the Union as a State, and without slavery, but leaving New Mexico and Utah open to its introduction. At the same time the celebrated "Compromise Measures" became a law and these were supposed to have settled the question of slavery for ever in the republic; the lapse of a few years proved, however, that this was a problem which admitted of no peaceful solution. By the treaty with Mexico, the United States did not acquire the Peninsula of Lower California, although they had military possession of it at that time. It was probably known to the authorities at Washington that it was a region of little value, as compared with the country to the north of it, or California proper.

LOWER CALIFORNIA.—Under this designation is comprised the whole peninsula, and it extends from Cape St Lucas to the boundary between the United States and Mexico, which is a line "drawn from the middle of the Rio Gila, where it unites with the Colorado, to a point on the coast of the Pacific one marine league due south of the southernmost point of the port of San Diego." The breadth of the peninsula varies very much, it being from five to six times as great between the parallels of 27° and 28° as it is opposite the Bay of La Paz. The area of Lower California has been estimated as 58,000 square miles; the recent charts of the American Hydrographic Office, based on original surveys, make the peninsula narrower than it was formerly believed to be, and its area has not been computed since these surveys were made; it will probably not exceed 50,000 square miles.

The interior of Lower California is chiefly known to us, as to its physical and geological structure, from a reconnaissance made by Messrs Gabb and Loehr, of the State Geological Survey of California, in 1867. This exploration was set on foot in order that some information might be obtained relative to the value of a concession made by the Mexican Government to an American company This grant was expected to lead to a settlement of the country, but the whole thing turned out a failure.

According to Mr Gabb, the peninsula is divided into three distinct portions. The northern and southern extremities have much in common with each other, while the middle division differs decidedly from the others in its physical characters. The most southern division consists chiefly of granitic rocks and high ranges, which with their spurs cover nearly the whole area from Cape St Lucas to La Paz. Within this district, and lying between the spurs of the mountains, are many small valleys, some of which are very fertile, and well supplied with water. According to the American hydrographic charts, there are in this part of the peninsula two well-defined ranges, and the culminating point is given as 6300 feet in altitude. It is in this region, about half-way from Cape St Lucas to La Paz, that the principal mines of the peninsula are situated; and these are the only ones which, thus far, have proved to be of much value. They are in the districts of San Antonio and Triunfo. In 1867 these mines were producing at the rate of about $20,000 in value of silver per month; and, from recent newspaper notices, it would appear that they are still worked with success. The ores are, however, refractory, and not easily treated.

Proceeding northwardly into the middle section of the peninsula, the granitic masses unite and form one mountain range, which runs parallel with the coast of the gulf, and at a distance of fifteen or twenty miles from it. It is known as the Sierra Gigantea, or del Gigante, and has an elevation of from 3000 to 4000 feet. Crossing this range and descending its western slope, its inclination is found to be very gradual, the granitic mass being flanked on that side by heavy accumulations of sandstone, which has a gentle dip away from the crest of the ridge. This sandstone is quite destitute of fossils, but is believed by Mr Gabb to be of Miocene age. It is cut by numerous volcanic dykes, and also contains great quantities of material of eruptive origin.. in the form of interstratified masses. In this portion of the peninsula the settlements are confined to the eastern base of the Sierra Gigantea. Here, at numerous points along the coast, there are small valleys, with good harbours

adjacent; and these little patches of country are very fertile and adapted to the growth of tropical and semi-tropical plants. By far the greater portion of the region, however, is extremely barren and forbidding; although occasional deep ravines and narrow valleys offer a marked contrast to the general sterility of the rest of the country. The northern division of the peninsula is considerably broken by mountain ranges, resembling in this respect the southern extremity. The culminating point is put down on the American hydrographic charts at 9130 feet in altitude, and it is called Mount Calamahue. Between the ranges are broad valleys, covered with grass, and said to possess some agricultural value, although as yet almost entirely unoccupied.

The dryness of the climate is the characteristic feature of the peninsula of Lower California; and although there are no reliable statistics of the rainfall it is undoubtedly very small. It is, indeed, very irregular, there being long periods of absolute dryness, in certain regions at least. The yearly average fall over the whole peninsula, for a long period of years, would perhaps not exceed three or four inches. As in the drier portion of Upper California, so here, when the rain does fall, it occasionally comes down in almost destructive quantity, over a very limited area, in the form of what are popularly known as "cloud-bursts."

Owing to the dryness of the climate in part, and also to the character of the Mexican Government, all the numerous attempts which have been made to settle Lower California have proved failures. The population at present is estimated at from 8000 to 15,000, about two-thirds of whom live near the southern extremity of the peninsula. The harbours on both coasts are numerous, and that of Magdalena Bay is hardly inferior in extent and availability to the Bay of San Francisco itself. Whale-fishing on the west coast, and especially about Sebastian Viscaino Bay, was, a few years ago, carried on very extensively. In the winter of 1848 there were fifty American ships anchored in the bay and lagoons of Magdalena, chiefly engaged in capturing the "California Grey" whale (*Rhachianectes glaucus*, Cope). The pearl-fisheries of Lower California have also for many years been of some importance; they are conducted by companies, and the divers are chiefly Yaqui Indians. The total value of the pearls obtained, within the last century and a half, has been estimated at five or six millions of dollars; but this, of course, can hardly be considered as being anything more than a rough approximation. On the whole, the prospects of Lower California are not very cheering; dryness and sterility are the dominating features of a very large portion of the country. The emigration schemes have all failed, and not without considerable suffering to the unfortunate people who from time to time have been deluded into the belief that the peninsula was a rich and fertile region. The attempts at mining for copper, which have been made at various points north of Triunfo, have all proved unsuccessful.

THE STATE OF CALIFORNIA. *Area.*—This is what is now always meant when the word "California" alone is used. It is in part the equivalent of the "Upper California" (Alta California) of the Spanish,—the present state of Nevada, and also the territories of Arizona and Utah, as well as parts of Wyoming and New Mexico, having been also included under that somewhat vague designation. California extends from the boundary already defined on the south to the parallel of 42°, which is the dividing line between this State and Oregon. On the east, the 120th meridian forms the boundary from 42° south to the intersection of that meridian with the 39th parallel, which takes place within the waters of Lake Tahoe, near its southern end. From this point the boundary runs obliquely in a south-easterly direction to the intersection of the 35th parallel with the Colorado River, and thence down the river to the Mexican boundary line opposite the mouth of the Gila. The whole area thus embraced has been variously estimated at from 155,000 to 188,981 square miles. The last-mentioned figures are those given in the latest document published in connection with the United States census,—General Walker's *Statistical Atlas*,—as well as in the *Report* of the Commissioner of the United States General Land Office for 1866. It is believed, however, that the first-named figures are much nearer the truth than the other higher statement, and that the area of California is somewhere between 155,000 and 160,000 square miles.

Topography.—The surface and climate of California, although extremely varied in character, bear everywhere a peculiar impress, very different from that of the Atlantic coast and Mississippi Valley States. The division of the year into two seasons—the wet and the dry—marks this portion of the Pacific coast in the most decided manner, and this natural climatic area coincides almost exactly in its extension with that of the State of California itself. Soon after crossing the Oregon line, we enter a region of summer and winter rains; and, in Lower California, although the entire precipitation is exceedingly small, it is, on the whole, decidedly tropical in its character.

Before, however, the nature of the Californian climate can be understood, it will be necessary to give some account of the physical structure of the State, and to indicate the interesting and somewhat peculiar character of the relief of its surface. California may be divided into three quite distinct portions, and these are very different from each other in importance,—the central being much the most densely populated, and in every respect the most valuable. This central portion is embraced between the parallels of 35° and 40°, and has, on its eastern side, the Sierra Nevada, and on its western the Coast Ranges, with the Pacific Ocean at their western base. Between these two mountain chains lies the Great Central Valley, which forms so marked a feature in the topography of the state. This valley is drained by the Sacramento River, flowing from the north, and the San Joaquin from the south, the two uniting about midway between the northern and southern extremities of the valley, and entering the Bay of San Francisco through Suisun and San Pablo bays, which latter is, in fact, but the northern expansion of San Francisco Bay itself. Suisun Bay, on the other hand, is rather the partly submerged delta of the united rivers, being shallow, and containing large, low islands covered with a dense growth of "tule" (*Scirpus palustris*). The entire length of the Great Valley is about 450 miles; and its breadth, which is small in its northern part, and gradually increasing towards the south, averages about 40 miles, including the lower foot-hills, so that the entire almost level area contains about 18,000 square miles. The direction of the valley is parallel with that of the ranges between which it is enclosed, or about N. 31° W.; but it gradually takes a more northerly course to the north of the Bay of San Francisco, in harmony with the change in the trend of the coast beyond the parallel of 39°. From the mouth of the Sacramento to Redding, at the northern head of the valley, the rise is 556 feet in 192 miles; and from the mouth of the San Joaquin to Kern Lake it is 282 feet in 260 miles. A striking feature of the Sacramento River is the fact that for 200 miles north from the mouth of the Feather River it does not receive a single tributary of any note, although walled in by high mountain ranges. Indeed, the whole of the Great Valley is thus surrounded; the only break being at San Francisco, where the channel which connects it with the sea—

the Golden Gate—is only one mile wide in its narrowest part. The region thus enclosed, computing it from the divide, or water-shed, of the enclosing mountain ranges, is 520 miles in length, and it has an average breadth of 110 miles. This gives an approximate area of 57,200 square miles, as stated by U. S. Irrigation Commissioners, their estimates having been made on the basis of the State Geological Survey maps. The drainage of this entire area reaches the sea through the Golden Gate. But before noticing the lakes and rivers which belong to the Great Valley, it will be desirable to give some idea of the mountain ranges in which these rivers take their rise; and it should be added in justice, that nearly all that is known of the detailed structure and elevation of the mountain chains of California is due to the work of the Geological Survey.

The Sierra Nevada, or Snowy Range, of California is, on the whole, the largest and most interesting chain of mountains within the limits of the United States. Its scenery is attractive, and in some respects quite unique; its vegetation is unsurpassed in grandeur, unless it be by that of the Australian forests; its mining resources are large, and have been the direct cause of the rapid peopling of the Pacific side of the continent and of the building up of eleven States and Territories in what was before almost an unknown region. In general altitude, the Sierra Nevada does not much excel some of the ranges of the Rocky Mountains proper, although it has one summit higher than any yet ascertained to exist in the United States, not including, however, the Alaskan territory. The length of the chain, from Mount San Jacinto to Mount Shasta, is about 600 miles; but, on some accounts, it would be more proper to consider the Sierra as beginning at the Tahichipi Pass and terminating at Lassen's Peak, in which case its length would be about 430 miles. The breadth of this great mass of mountains varies from 75 to 100 miles; and it narrows towards the north, while its altitude also declines in the same direction. The slope of the range is everywhere long and gradual on the west, and short and precipitous to the east, in which latter direction, of course, the general level of the Great Basin is attained, and this is from 4000 to 5000 feet above the sea. The highest part of the range is between the parallels of 36° 30′ and 37° 30′; here the passes are about 12,000 feet in elevation above the sea-level, and the peaks range from 13,000 to 14,886 feet in altitude, the culminating point, Mount Whitney, being about 600 feet higher than any peak yet measured in the Rocky Mountains. From this peak, going north, the range declines gradually, and at the point where the Central Pacific Railroad crosses it the summit is only 7000 feet above the sea; this is in latitude 39° 20′. The slope of the Sierra in the central part of the State opposite Sacramento is about 100 feet to the mile, the range being there seventy miles in breadth between the valley and the crest; farther south, opposite Visalia, the average rise is as much as 240 feet to the mile, up to the summit of the passes, and 300 feet to the peaks. In this part of the range, the slope on the east is very abrupt, being as much as 1000 feet to the mile from the summit to the level of Owen's Valley, a descent of about 10,000 feet. The western side of the Sierra Nevada is furrowed by extremely deep and precipitous gorges, or cañons, as they are universally called in California. These are narrow at the bottom, where there is usually barely room for the river to run at an ordinary stage of water; their sides slope upwards at a very steep angle, often as much as 30°; and they are sunk from 1 to 3000 feet, or even more, below the general level. These cañons become more and more marked features of the range as we proceed north in the Sierra; and where the volcanic formations have spread themselves uniformly over the flanks of the mountains, so as to form a smooth and almost level surface, as is the case over an extensive area, the contrast between the deep and precipitous cañons and the plain-like region, with its gentle slope to the west, in which they have been excavated, is a very marked one.

The Coast Ranges form a large mass of mountains, almost as broad as the Sierra, but much inferior to it in elevation, and at the same time more complicated in details. The Sierra Nevada is essentially one range or chain, with great simplicity of structure. It is only here and there that, along the crest or near it, a double line of summits exists, with deep longitudinal valleys between, which are occasionally occupied by lakes, as in the case of Lake Tahoe; while the Coast Ranges, on the other hand, are made up of numerous broken and indistinct chains, each of which usually has a distinct name, the different groups of ranges having, however, on the whole a well-marked parallelism with the coast. Near the Bay of San Francisco the culminating summits are about 4000 feet in altitude; to the north and south of the bay the elevation of the ranges increases. Monte Diablo, twenty-eight miles distant from San Francisco in a north-north-easterly direction, is 3856 feet in height, and forms a well-known land-mark, being, from its somewhat isolated position on the north, a very conspicuous object over much of the central portion of the state. The view from its summit is remarkably comprehensive, as is that from Mount St Helena, at the head of Napa Valley, sixty miles north of San Francisco, and 4343 feet in height.

The flanks of the Coast Ranges on the western side of the Great Valley are very scantily provided with forests, and there is not a single stream on that side permanent enough to reach either the Sacramento or San Joaquin throughout the entire year. The only streams which carry water in summer on the west side of the Sacramento Valley are Puta, Cache, and Stoney creeks, and these all disappear during the dry season, soon after leaving the foot-hills. On the eastern side, however, *i.e.*, of the valley, the conditions are greatly changed. The rain-fall, almost entirely cut off on the eastern slope of the Coast Ranges, becomes considerable on the western side of the more elevated Sierra, and numerous large rivers are fed from the melting snow during the summer, although, towards the close of the dry season, the body of water which they carry has usually become very much diminished. The streams tributary to the Sacramento on the east side are—the Feather, Yuba, American, Consumnes, Mokelumne, and several other smaller ones. The Feather has the largest drainage area of any river having its source in the Sierra. It runs for a long distance parallel with the Sacramento, receiving on the east all the drainage which would otherwise run into that river. There are no lakes in the Sacramento division of the Great Valley; but at its southern extremity there are several, one of which is of large size, having an area of not less than 700 square miles. This is Tulare Lake, which, together with Kern and Buena Vista lakes, receives the drainage of the southern part of the Sierra, by the Kern, Kaweah, King's, and other smaller streams. Tulare Lake is quite shallow, being only 40 feet deep; its banks are low and reedy (hence the name, Tulare, a place of reeds or tules), and in wet seasons it overflows them, and becomes greatly extended in area. At such times the excess of the drainage passes off into the San Joaquin; but in dry seasons the evaporation is so great that there is no discharge in that direction. The northern branch of the San Joaquin heads in the grand group of summits of which Mounts Maclure, Lyell, and Ritter are the culminating points; the southern rises on the north side of Mount Goddard. The united stream issues from the mountains at Millerton; and, after gaining the centre of the valley, it turns and runs at right

angles to its former course, receiving three important tributaries and several smaller ones on the east, but not a single permanent one from the west. The area of the Sierra drained by the San Joaquin is only about half that of which the Feather collects the surplus waters.

There are several large mountain lakes in California, some of which are of pure and fresh water, while others are alkaline, being without any outlet. The finest of these is Tahoe, which lies on the very summit of the Sierra, and at an elevation of about 6200 feet. It has a length of about twenty miles, and is 1500 feet deep, its water being extremely pure, as it contains only three grains of solid matter to the gallon. The overflow of this body of water passes off by the Truckee River, and enters Pyramid Lake, where it "sinks," or disappears by evaporation. Clear Lake is another beautiful sheet of water, in the Coast Ranges, and about the same length as Lake Tahoe, but much narrower and more irregular in shape. Owen's Lake is the "sink" of Owen's River, and is about eighteen miles long. Mono Lake is the sink of the streams rising in the Sierra between Mount Dana and Castle Peak. It is about fourteen miles long, and nine wide, and lies at an elevation of about 7000 feet above the sea-level. There are several other large alkaline lakes in Lassen and Modoc counties, which receive the drainage of the eastern slope of the Sierra, within the limits of the State. Death Valley is the sink of the Amargosa River, and it has evidently been once an extensive lake, although now only a mud-flat in ordinary winters, and a dry, alkaline, desert plain in summer. All these lakes and depressions show very plainly, by the terraces which surround them, that the water was formerly much more abundant, and stood at a higher level than it now does.

North of the parallel of 40°, where the Coast Ranges and the Sierra unite, and the Great Valley disappears, the country is extremely rough and very thinly inhabited. The seven counties which are included within the region north from the head of the Sacramento Valley to the State line had in 1870 a population of only 19,269, and they had all lost in numbers during the previous decade. The counties of Lassen, Siskyou, and Modoc, which are embraced in the north-eastern corner of the State, are chiefly covered with volcanic plains, very dry and barren, lying between precipitous, although not very lofty, ranges. The waters of this region have no drainage to the sea. These three counties, with an area as large as that of Belgium, had in 1870 a population of only 8175, or less than one to the square mile. The north-western corner of the State is also extremely rough and mountainous, and a large part of it quite uninhabitable. The ranges which intersect it, and which are known as the Siskyou, Salmon, and Scott Mountains, seem to be geologically the continuation of the Sierra Nevada. They are from 6000 to 8000 feet in height; but they have never been accurately mapped, and very little is definitely known about them, although gold washings have been carried on for many years in some of the valleys bordering the Klamath River and its tributaries.

That portion of California which lies to the south and east of the southern inosculation of the Coast Ranges and the Sierra, comprising an area of fully 50,000 square miles, is also very thinly inhabited, with the exception of a narrow strip along the coast. Nearly all of San Diego and San Bernardino counties belongs to the Great Basin system, having no drainage to the sea. Los Angeles County, however, has within its borders some of the most fertile lands in the state. These form a strip about twenty miles wide along the coast; the north-eastern half of the county on the other hand, is extremely barren. The region lying east of the Sierra Nevada, and between the crest of that range and the boundary of the State, chiefly divided between the two counties of Mono and Inyo, is also a very mountainous tract of country. Owen's River runs through it from north to south for a distance of 180 miles, emptying into the lake of the same name, lying at the south end of Owen's Valley, and with no outlet. Here the scenery is extremely grand, the valley being very narrow and the ranges on either side elevated from 7000 to 10,000 feet above the lake and river. The Inyo range, on the east, is quite bare and destitute of timber, and its summits are only occasionally whitened with snow for a few days during the winter, the precipitation being almost entirely cut off by the Sierra on the west. East of Owen's Lake are several parallel ranges of mountains; and beyond them, at a distance of about forty miles from the lake, is Death Valley, which is about 150 feet below the sea-level. The name was given in allusion to the fate of a party of emigrants, who perished here, many years ago, from thirst, and perhaps starvation. Between Owen's Lake and Death Valley are the Panamint Mountains, which have lately been the scene of considerable mining excitement. A portion of the extreme southern part of the State in San Diego County is also below the sea-level. Here is a depressed area of fifty miles in length, the width of which is unknown; in its lowest part it is over 300 feet beneath the level of the sea. Dry Lake occupies the greatest depression of this area at the entrance to the Coahuila Valley.

There are many fine points in the scenery of California, some of which have already become well known from the descriptions of pleasure-travellers who have flocked to the State from all parts of the world. The granite pinnacles and domes of the Highest Sierra opposite Owen's Lake; the snowy cone of Mount Shasta, rising 10,000 feet above the adjacent plains; the lovely valleys of the Coast Ranges, with their peculiar vegetation,—all these have their charms; but the point which is most attractive of all is the Yosemite Valley. This is situated in the Sierra, about 150 miles in a direct line, a little south of east, from San Francisco. Its elevation is 3950 feet above the sea, and it is hemmed in by cliffs varying from 2000 to 3000 feet in elevation. The principal features of the Yosemite, and those by which it is distinguished from all other known valleys, are—first, the near approach to verticality of its walls; second, their great height, not only absolutely, but as compared with the width of the valley itself; and finally, the small amount of talus or *débris* at the base of these gigantic cliffs. The waterfalls in and about this valley are also of wonderful beauty and variety. Those of the Yosemite Creek, which descend from the cliffs on the north side, are most remarkable for their height, which is, in the whole, not less than 2600 feet, but divided into three parts, with one vertical fall of 1500 feet. The Nevada and Merced Falls of the Merced River, which flows through the whole length of the valley, combine great height with a large body of water, and are wonderfully grand. The Half Dome is one of the most striking features of the Yosemite, its elevation being 4737 feet above the bottom of the valley, with an absolutely vertical face of 1500 feet at the summit, turned towards the Tenaya Fork of the Merced, above which it rises. The scenery of the cañon of the Tuolumne River, which flows parallel with the Merced, a few miles further north, is also extremely picturesque, and remarkable especially for the great number and variety of the cascades which occur at short intervals in the deep gorge, the walls of which are bare and almost vertical precipices, in places more than a thousand feet high. The river, which is not much less than a hundred feet wide, falls 4650 feet in a distance of twenty-two miles. A few miles farther down, the narrow gorge opens out into a beautiful valley, in many respects a wonderful counterpart

of the Yosemite, although inferior to it in grandeur. This is called the Hetch-Hetchy. Above the Yosemite Valley the scenery of the High Sierra is very attractive, immense conical knobs or domes of granite being a prominent and very characteristic feature of this and other portions of the Sierra. Mount Dana, a little over 13,000 feet in height, dominates over the region above the Yosemite; and from its summit, which is quite easy of access, a magnificent panorama may be had of the Sierra Nevada, with Mono Lake, nearly 7000 feet below, spread out like a map, and beyond it the lofty, and, in some instances, snow-clad ranges of the Great Basin, while several well-formed and very large volcanic cones are seen just to the south of the lake.

Climate.—The climate of California presents many features of interest, differing considerably from those obtaining in the Eastern and Mississippi Valley States, which have furnished a majority of the immigrants to the Pacific coast and Great Basin. There can be no doubt that emigration to California has, especially within the past few years, been greatly stimulated by the desire of people at the East to escape the sudden changes, the intense heats of summer, and the bitter colds of winter, which characterize the climate of the whole country east of the Rocky Mountains.

The climate of California is very different in different parts of the State, according to distance from the ocean, situation with reference to the mountain ranges, and altitude above the sea-level. But there are certain peculiar features which obtain all over the State. In the first place, the division of the year into two seasons—a dry and a rainy one—is the most marked general characteristic of the Californian climate. But, as one goes north, the winter rain is found to begin earlier and last longer; while, on the other hand, the south-eastern corner of the State is almost rainless. Again, the climate of the Pacific coast, along its whole length, is milder and more uniform than that of the States in a corresponding latitude east of the mountains. Thus, we have to go as far north as Sitka, in latitude 57°, to find the same mean yearly temperature as that of Halifax, in latitude 44° 39. And in going south along the coast, we observe that the mean temperature of San Diego is six or seven degrees less than that of Charleston and Vicksburg, which are nearly in the same latitude as San Diego, and situated, one on the Atlantic, the other on the Mississippi River. But, in addition, we notice that the means of summer and winter are much nearer the mean of the year in California than in the east. Thus, comparing Washington and San Francisco, we have—

	Mean of Year.	Mean of Summer.	Mean of Winter.
San Francisco,..	56	60	51
Washington,.....................	56·07	76·3	36·05

This condition of things is not so marked as we advance into the interior of California; but everywhere in the state the winters are comparatively mild, and the heat of summer is much less disagreeable in its effects, because the air is exceedingly dry and the evaporation proportionately rapid. The climate of San Francisco is indeed wonderfully uniform; and the bracing, cool air which sweeps in from the ocean during the afternoons of the summer, although not favourable to persons with weak lungs or sensitive throats, is the very breath of life for those who are in vigorous health. One great drawback to the enjoyment of the delightful climate of California, however, is the dust of summer, which seems, until one becomes accustomed to it, quite unbearable. A more serious difficulty in this State is the extreme variability in the amount of rain which falls from year to year; and this uncertainty is something which must always be present in the mind of the farmer as likely seriously to influence his future. Some years are so dry that the crops are almost an entire failure, except directly on the coast, or where artificial irrigation is practised; other years are so wet, that serious inundations occur. During the interval from 1850 to 1872, the yearly rain-fall ranged, at San Francisco, from 7·4 inches to 49·27 inches. In going southward from San Francisco, the mean rain-fall decreases along the coast, and at San Diego it is only about 10 inches. At Fort Yuma it is a little over 3 inches. In the Sierra the annual precipitation increases as we rise in altitude; it is almost entirely in the form of snow at elevations greater than 6000 or 7000 feet; and this snow, as it melts during the summer, furnishes a store of water of immense importance to the State, supplying, as it does, the numerous ditches or small canals, which have been built, in connection with great reservoirs high up in the mountains, for supplying the miners, and which are more and more utilized for agricultural purposes, as the placer-mining claims cease to be worked. As there is no fall of rain or snow of any consequence on the Sierra during the summer, the accumulated stock of the previous winter melts gradually, and after a succession of dry seasons, it almost entirely disappears from the summits of the range. If, on the other hand, two or more rainy winters follow each other, the crest retains a large amount of snow to add to the next year's stock. The climatic conditions are such, however, that there are no true glaciers formed anywhere in the Sierra, although the traces of former ones are everywhere visible along the highest part of the range. These ancient glaciers once covered the summits and extended quite low down in some of the valleys,—notably in that of the Tuolumne, where the ice-flow may once have been from thirty to forty miles in length. The walls of the Hetch-Hetchy Valley are beautifully scored and polished by former glaciers, which once entirely filled the upper portion of this grand cañon. The nearest approach to a glacier which at present exists in the Sierra is to be found on Mount Shasta, on the north side of which, and almost at the summit, are large masses of ice having many of the characteristics of the genuine glacier.

The winds of California are, during the summer, exceedingly regular in their movement. As the interior becomes heated by the sun, the air rises, and a current of colder air rushes from the sea to take its place. Wherever there is an opening, therefore, in the Coast Ranges down to the level of the sea, there the wind will blow through it fiercely during the hottest part of the summer day, towards the interior. Thus, in going from the Bay of San Francisco towards the mountains, or up either the Sacramento or the San Joaquin Valley, the wind will be with the traveller. In fact the current spreads out fan-shaped from that point, and reaches far up from the ocean. A very strong wind and cool and bracing weather at San Francisco are indications of exceptionally hot days in the interior. At night the breeze slackens, and usually ceases altogether, a light mist often enveloping the city of San Francisco. At the same time, the cooler air draws gently down the mountain slopes, in opposition to its direction during the day. In the interior, the days, in summer, are extremely warm, the thermometer sometimes rising to 120° in the shade, and 160° or 170° in the sun. The farther one goes from the Bay of San Francisco, the hotter it becomes. At night, however, the radiation is rapid, and the temperature falls, so that a warm covering is almost always needed. The south-eastern corner of California is exceedingly dry, and has a very high temperature. At Fort Yuma the mean of the year is 76°, and the heat in summer is almost intolerable, the thermometer ranging above 90°, sometimes for weeks, both by night and by day. Among the peculiarities of the Californian this is not one of the least striking, that, as one

leaves the Sacramento and San Joaquin plains, and travels into the mountains, it becomes quite perceptibly warmer, at least for the first 2000 or 3000 feet of ascent. Thus, the mean temperature of the year at Colfax, 2400 feet above the sea-level, was, for 1871, 1°·6, and for 1872, 1°·4 higher than that of Sacramento, which is only 30 feet above the sea. As high up as 8000 or 10,000 feet the days in summer are comfortably warm, and even on the high peaks of the Sierra, at 12,000 or 13,000 feet of altitude, at mid-day it is usually so warm that an overcoat is not needed. At night, however, at these elevations, it is almost always so cold that frost occurs, although occasionally it is very warm all night long, even at as great an altitude as 8000 feet. It adds very much to the pleasure of travelling in the High Sierra that the weather is, by day, almost all summer long, delightfully mild and clear, and without rain; so that one of the greatest discomforts to which tourists are exposed in Switzerland and most other regions of pleasure-travel is here entirely unknown.

Geology.—The geological structure of California is comparatively simple, although the extreme paucity of fossils in the rocks of the gold region for a long time rendered it impossible to ascertain the age of the auriferous belt. It is also true that, for similar reasons, the formations which make up the main body of the Coast Ranges were not easily made out. A geological survey was authorized by the legislature in 1860, and continued, with occasional stoppages, until 1874. In the published volumes and maps which have been issued in the course of this work, almost all that is known with accuracy in regard to the geology and mineral resources of the State may be found.

The Sierra Nevada first claims attention, as being the dominating range It has a central core or axis of granitic rock, which forms almost the whole body of the range in its southern portion, diminishing in width as it is followed towards the north. All the higher points of the Sierra, in its most elevated portion, are of granite. Farther north there are a few high peaks of metamorphic rock, and many of the summits are capped with volcanic materials. Flanking the granite is a very heavy mass of slaty metamorphic rocks, commonly known as the auriferous belt of the Sierra. This consists chiefly of argillaceous, chloritic, and talcose slates, with a great variety of other metamorphic rocks in smaller amounts, and some large, apparently isolated patches of limestone, which succeed one another in the line of direction of the axis of the range. The strike of the slates is usually parallel with that of the axis of the range, and their dip is, in general, at a high angle towards the east. Low down in the foot-hills, sandstones of Tertiary and Cretaceous age occur in considerable quantity. From the Stanislaus River towards the south, these strata are Tertiary, and they form quite a broad belt on White River and Pose Creek. On the American River, and north of it, the Cretaceous rocks are occasionally well developed and full of organic remains. All these beds rest in almost horizontal position on the upturned edges of the auriferous slates, showing that the elevation and metamorphism of the chain of the Sierra took place previous to the Cretaceous epoch. These beds are of marine origin; but there are very extensive masses of sedimentary materials higher up in the Sierra which are fluviatile and fresh-water deposits, and they are associated with great quantities of volcanic detritus and solid lava which has evidently come down from the higher portions of the chain. The eruptive materials do not usually lie where they were ejected, but seem to have been carried far from their original position by currents of water, as they are made up, in great part, of rolled or brecciated masses, and are interstratified with gravels and finely laminated clays. These latter often contain impressions of leaves and whole trunks of trees, usually silicified, as well as bones of land and aquatic animals. The character of these fossil remains indicates that the formation is of late Tertiary age, and it may be considered as Pliocene. Although the crest of the Sierra is frequently crowned by large masses of volcanic materials, there are no indications of present activity along the range, and only occasionally can remains of ancient crateriform openings be seen. In Plumas County, however, and especially in the neighbourhood of Lassen's Peak, there are several solfataric areas and well-formed cinder cones, some of which exhibit very marked appearances of recent action. From here northward, volcanic masses cover more and more of the higher regions, and almost the whole of the north-eastern corner of the State is exclusively occupied by rocks of this character. Lassen's Peak (10,577 feet) and Mount Shasta (14,440 feet) are both extinct volcanoes, and the latter has, near its summit, hot springs and indications of solfataric action. The auriferous slates of the Sierra contain occasional fossils; and, in quite a number of localities, these have been found in close proximity to well-marked and productive veins of quartz, which are now, or have formerly been, extensively worked for gold. These fossils are of Jurassic age, and no Silurian or Devonian forms have ever been discovered anywhere in the Sierra. In Plumas County, Triassic fossils have also been discovered, but only in one locality of limited extent. These are, however, identical with species belonging to the Alpine Trias, which have been found in large quantities, and in numerous localities, on the eastern side of the Sierra, and which prove that this interesting group of rocks has a wide distribution on the Pacific side of the continent. The limestone belt, already mentioned, appears to be entirely destitute of organic remains, except in the extreme northern part of the State, where, in one or two localities, it has been found to contain well-marked carboniferous types. Farther south, this rock has become much metamorphosed, and is in many places converted into marble, while its organic remains appear to have become entirely obliterated.

The Coast Ranges are made up almost entirely of Cretaceous and Tertiary marine strata, chiefly sandstones and highly bituminous shales. The Cretaceous rocks occur from the Cañada de las Uvas northward along the east side of the Coast Ranges, gradually occupying more and more space in a northerly direction. After passing the Bay of San Francisco, this formation makes up nearly the whole mass of the mountains, which grow more elevated and rougher towards the north, the rocks being much metamorphosed and broken by granitic intrusions. In the vicinity of Clear Lake (latitude 39°) there is a belt of volcanic materials, accompanied by hot springs, and solfataric action, crossing the ranges from east to west. The Coast Range mountains have been much disturbed, and in part elevated during the most recent geological epoch, as large masses of strata of Pliocene age are found in various localities to have been turned up on edge; but volcanic activity seems to have been more general and continued to a later date in the Sierra than in the Coast Ranges. Some of the granitic masses along the shores of the Pacific are more recent than the Miocene Tertiary, as strata of this age have been uplifted and turned up on edge by the protruding granite. Indeed, everything in the Coast Ranges points to great geological disturbances as having occurred at a very recent date. Among the illustrations of this condition of things, the changes produced by earthquakes in modern times may be cited. Like all the rest of the Pacific coast, California is liable to these disturbances, and this circumstance has undoubtedly had considerable influence in retarding the settlement of the State. No year has been known, since the conquest of the country by the Americans, so disastrous as were the spring

and summer of 1812; the destruction of life at that time would probably have been large if California had been as thickly settled as it now is. During the whole of May of that year the southern part of the State was violently agitated, and the disturbances continued with more or less severity through the entire summer. So frequent and violent were the shocks that the people abandoned their houses and slept on the ground. In September the missions of San Juan Capistrano and La Purisima were destroyed, and thirty or forty persons killed at the first-named place; also a considerable number at Purisima, but how many was never ascertained. At Santa Barbara a tidal wave rushed into the interior; but the inhabitants, having observed the previous recession of the sea, had fled to the adjacent high ground, and thus escaped destruction. In the year 1808, in the months of June and July, there were numerous shocks at the Presidio of San Francisco. On the 8th of October 1865 the whole region adjacent to the Bay of San Francisco was violently disturbed, and many buildings thrown down, while hardly one of brick or stone within the city itself escaped injury; but few lives were lost, although great alarm was felt. Since that time there has been no severe shock having its focus near the coast; but in 1872 the whole Sierra Nevada, and the adjacent State of Nevada, were most violently shaken, the centre of the shock having been along the axis of the range, from which the waves were propagated east and west with about equal velocity. Immense quantities of rock were thrown down from the granite pinnacles in the Highest Sierra. The small settlement of Lone Pine, in Owen's Valley, at the east base of the mountains, was completely demolished, and between twenty and thirty persons killed. Luckily the heaviest part of the shock was limited to a region hardly at all inhabited, so that the destruction of life was insignificant in comparison with the extent and violence of the disturbance. Lighter shocks continued to be felt, for two or three months after the first severe one, through the whole extent of Owen's Valley. The extinct or dormant volcanoes, of which there is a fine group midway in the valley between its two extremities, showed no signs of being affected by this exhibition of the seismic forces. There are in the Coast Ranges long and very straight fissures in the rocks, which have been produced by earthquakes in modern times; and these have, in some instances, been accompanied by changes in the relative level of the ground on each side.

Mining.—California was for many years chiefly known to the world as the region where gold was obtained in extraordinarily large quantities. The excitement occasioned by the discovery of the precious metal was very great throughout the United States, and this and the finding of an equally important auriferous region in Australia, only two or three years later, produced an immense effect on the commerce of the world, stimulating emigration in a way never before dreamed of. The existence of gold had long been known in California, and washings had been carried on in the southern part of the country, near the San Fernando Mission, for several years, having commenced there as early as 1841. No discovery had been made, however, which attracted much attention, or caused any excitement, previous to the occupation of the country by the Americans. In January 1848, a piece of native gold was picked up in an excavation made for a mill-race on the South Fork of the American River, at a place now called Coloma. It was several months, however, before the number of persons brought together by this discovery had become large; but, by the end of December, washing for gold was going on all along the foot-hills of the Sierra, from the Tuolumne River to the Feather, a distance of 150 miles. The first adventurers came from Mexico, the South American coast, and even from the Sandwich Islands. The excitement extended to the eastern Atlantic States in the course of the autumn and winter succeeding the discovery; and, in the spring of 1849, the rush of emigration across the plains, and by way of the Isthmus of Panama, commenced; and it was estimated that 100,000 men reached California during that year, among whom were representatives of every State in the Union. The emigration to the land of gold was continued, with but little abatement, during the three succeeding years; but the excitement fell off in a marked degree in 1854, at which time there was a decided reaction throughout the United States in regard to mining matters. The Californian discoveries had given rise to a general search for metalliferous deposits in the Atlantic States; and this had been followed by wild speculations, a great deal of money having been sunk in opening new mines, and in attempting to develop old ones which had never yielded anything of value. How many miners were actually at work in California at the time of the greatest excitement can only be a matter of conjecture. It is generally believed that not less than 50,000 men were engaged in mining for gold at the close of the year 1850. Those who had good opportunities for observing think that there were as many as 100,000 at work in 1852 and in 1853. At the time of their greatest productiveness, the yield of the Californian gold washings reached about sixty-five millions of dollars in value a year; this was from 1850 to 1853. If there were 75,000 miners actually employed at this time, the average amount obtained must have been fully $8 a day per man. The average is thought by many to have been as high as $20 a day during the year following the first discovery. At this time the diggings for gold were chiefly along the rivers. These were "flumed,"—that is, the water was taken out of the natural channel by means of wooden flumes,—and the accumulations of sand and gravel in the former beds were washed. All the small "gulches" or ravines leading down the sides of the steep and narrow valleys, or cañons, were worked over, either with or without the aid of water. These were the first and richest "placers," and in them the precious metal was most unequally distributed. Those who first got hold of the rich bars on the American, Yuba, Feather, Stanislaus, and the other smaller streams in the heart of the gold region, made sometimes from one to five thousand dollars a day; these rich spots were chiefly very limited in area, and after one was worked out, it might be days or weeks before another was found.

During the year 1851 the miners, not finding any longer room for employment on the river-bars, began to extend their "prospecting" to the higher ground, and it was not long before it was discovered that the so-called "high gravels"—that is, the detrital deposits of Tertiary age—contained gold, although the quantity was so small that washing it in the ordinary way was not profitable. This led, in 1852, to the invention of the "hydraulic process" of working the auriferous detritus, the idea of which is due to E. E. Matteson, a native of Connecticut. This process has now received an immense development, successive improvements having been made in the method and the machinery for applying it, until the results have become indeed wonderful. The "sluice" which is used with it, and, in fact, in all gold-washing in California at present,—almost without exception,—is also a Californian invention. Previous to its introduction, first the "rocker" and then the "tom" were employed. During the first years of the Californian excitement there was much wandering about within the State and in the adjacent territories in search of new "diggings," the miners seeming to have the fixed idea that somewhere an auriferous centre or focus would be found, vastly richer than any thing previously discovered. They were an excitable body of men, and frequently left

valuable localities in search of something better, always hoping that deposits of unheard-of richness would be developed. Occasionally a kind of frenzy would seem to seize on them, and thousands would flock to some new and perhaps distant locality, on the strength of newspaper reports, where many would perish from disease and starvation, the rest returning in poverty and rags. Thus, in 1855, the Kern River fever raged through the State, at least 5000 miners going to that distant region of the Sierra, only to find that the gold deposits were limited in extent, and already worked out. In 1858 the "Fraser River rush" occurred; and this was more disastrous to California than the most deadly pestilence would have been; for it caused a terrible amount of suffering. Nearly 20,000 men left the State for that remote region, where few met with even moderate success, while all suffered great privations, and many died, the survivors coming back in a state of complete destitution. The shallow "placer diggings" of California are now pretty well worked out, and the gold at present is chiefly obtained from the hydraulic mining operations and from the quartz veins. The deep or high gravels, as they are indiscriminately called, and which are worked by the hydraulic process, lie chiefly in Nevada, Placer, and Sierra counties, in the region extending between the branches of the American and Yuba rivers. These gravels are usually associated with heavy deposits of volcanic materials, and, indeed, they are often entirely covered by immense flows of lava, under which the workings are carried by means of tunnels.

All the operations connected with the exploitation of the large hydraulic "claims" are usually on a grand scale. As much as twenty-five, or even fifty, tons of powder are sometimes used in a single blast to loosen the gravel, so that it can be acted on with ease by the jet of water thrown from the "pipes." To give an idea of the force of the agent thus employed, it may be stated that, when a six-inch nozzle is used, under a head of 300 feet, as is sometimes done, not less than 1600 cubic feet of water are discharged in one minute, with a velocity of 140 feet per second. The water, as it thus issues from the nozzle, feels to the touch like metal; and it retains its cylindrical form unbroken until it strikes the gravel bank at a distance of a hundred or more feet. The detritus, thus powerfully acted on, crumbles rapidly, and the disintegrated material is carried by the current into the sluice-boxes, where it leaves its auriferous particles in the "rifles," which are chinks or cavities between the bars or blocks of wood or stone with which the bottom of the sluice are lined. Gold-mining in the solid rock—or quartz-mining, as it is usually called, because the gangue or vein-stone which carries the gold is almost exclusively quartz—is also extensively carried on in California, having been begun as early as 1851. The mines are scattered over the State from San Diego to Plumas counties; but the most important and productive ones are in Amador and Nevada. The distribution of the gold in the veins is exceedingly irregular, and, consequently, the business of quartz-mining has been, in most cases, a very uncertain one. A large number of the principal workings are on, or in the neighbourhood of, what is known in California as the "Great Quartz Vein," or the "Mother Lode," an immense development of quartz, which has been traced from Mariposa County to Amador, over a distance of eighty miles,—not continuously, but in a series of nearly parallel belts, or lenticular masses, with barren intervals between them; these have very nearly the same direction, and are parallel with the axis of the Sierra. It is on the Great Quartz Vein that the celebrated Mariposa mines are situated; which, however, have not, on the whole, proved successful. In the same position are the mines of Amador County, among which the one formerly called the Hayward Mine is the best known, and for a long time one of the most profitable. The mass of quartz worked in this mine was of great size, although of low tenure in gold. It was, for some years, the deepest mine in the country; but several of those on the Comstock Lode in Nevada have now attained a considerably greater depth.

Silver-mining has been attempted in many localities in California, and much money spent in trying to develop the argentiferous lodes which have from time to time been discovered. A few years ago, there was a great excitement on the very summit of the Sierra in regard to supposed valuable silver-bearing veins, and particularly at a locality called Meadow Lake, in Nevada County. Quite a number of mining camps and towns were built up, one of which had for a time several thousand inhabitants. Nothing permanently valuable was discovered, however, and the region was soon entirely abandoned. The most persistent efforts have been made, for the past ten years, to work argentiferous deposits in the volcanic rocks near the summit of the Sierra, in Alpine County, at and near Silver Mountain. Although it does not appear that any mine in this region has been successful, the expenditure is still kept up. Slate Range, a little to the east of Owen's Lake, was the scene of considerable excitement some ten or twelve years ago, rich silver ores having been discovered there; but it was found that mining could not be made profitable in that distant region destitute of water and fuel. Quite recently, the Panamint Range, in the same vicinity, has attracted much attention. The only paying silver mines in the State seem, however, to be those in the Inyo Range, at Cerro Gordo, where the ore is chiefly galena, rich in silver, and also containing considerable gold. The yield of this district in the year 1872 was nearly a million of dollars in value, six-tenths of which was silver. Silver.

Quicksilver has been extensively mined in California, the mine of this metal at New Almaden, Santa Clara County, having been worked previous to the gold excitement. All the workable deposits of cinnabar thus far known to exist are situated in the Coast Ranges, and they are chiefly limited to the metamorphic Cretaceous group of rocks, in which they are associated with serpentine, imperfect jasper, hornstone, and chalcedony. By far the most important mines are those at New Almaden, a few miles west of San José. These produced, in their palmy days, during the years 1853 to 1857, and 1861 to 1869, from 2,500,000 to 3,500,000 lb of quicksilver per annum. In 1870, the production had fallen off to 1,000,000 lb. The total production of the New Almaden mines between 1850 and 1870 was a little over 40,000,000 lb. The New Idria Mine is in Fresno County, about ninety miles south of New Almaden. This has also been, for some years, a quicksilver-producing locality of considerable importance. Cinnabar also occurs in considerable quantity at numerous places north of the Bay of San Francisco, in Napa and Lake counties. The most important mine in this region is the Redington, near Knoxville, in Lake County. The export of this metal from California was, in former years, very large, reaching, in 1868, the amount of 44,506 flasks, or 3,404,709 lb; in 1870, it was only 6,359 flasks, although the production for that year was estimated at 28,600 flasks, or 2,187,900 lb, of which 12,000 were the product of the New Almaden mine, 7600 of the New Idria, and of the remainder, about one-half was from the Redington, and the rest from various smaller mines north of the Bay of San Francisco. Quick-silver.

Copper ores occur in a great many localities within the limits of the state of California, and at some of these a large amount of work has been done, although at the present time there does not seem to be a single locality where the ores of this metal are now mined. Quite large masses of nearly pure native copper, mixed with the red oxide have Copper.

been found in the north-western corner of the State, and also farther south in the Coast Ranges. No permanent mine has, however, yet been developed at any point on the west of the Great Valley. In the foot-hills of the Sierra, at a place known as Copperopolis, in Calaveras County, there is a very extensive deposit of copper ore, which was actively mined some ten years ago, producing very largely for a time. The mass of ore here was, in places, as much as 30 feet wide, although not of high grade. In 1864 the value of the shipments of copper ore from California was a little over a million dollars; this was almost all from one mine, **Tin.** the Union, at Copperopolis. Tin has been discovered at one locality in the southern part of the State, in the Temescal Range, about forty miles south-east of Los Angeles; and mining was attempted here, but the locality has been for some time abandoned. Zinc and lead occur, in the form of the sulphuret, in a great number of the quartz veins of the gold-bearing belt; they are generally present, however, only in small quantity, and have not been made the object **Iron.** of mining enterprise. Iron ores are also found, in several localities, in large quantity; the want of suitable cheap fuel has prevented these ores from being utilized, and all the iron consumed on the Pacific coast comes from the Atlantic States **Coal.** or from Great Britain. Coal of the true Carboniferous period does not occur anywhere on the North American continent west of the eastern base of the Cordilleras; but there are, at various points, extensive deposits of lignite and imperfect coal; in some of these, the woody structure is entirely obliterated, and the substance may with propriety be called coal. It is rarely the case, however, that it does not contain a large percentage of water. These deposits are both of Tertiary and Cretaceous age; but at the localities extensively worked in California and on Vancouver Island, the beds belong exclusively to the last-named group. The only mines of coal of any consequence in California are those of Monte Diablo, so called because situated on the north slope of that mountain, and a few miles from the entrance of the San Joaquin River into Suisun Bay. The coal raised at these mines is of tolerably good quality for domestic use; but it cannot be used for ocean steaming or for making gas, as it contains a large amount of sulphur, and from 10 to 12 per cent. of water. These mines have yielded of late about 175,000 tons per annum. There is also a large deposit of about the same quality, and the same geological age, on Eel River, in Mendocino County. This is too far from navigable water to be utilized at present, as it cannot compete with the more accessible deposits on Vancouver Island, and at Bellingham and Coos bays, or with those more recently opened near Seattle in Washington **Petroleum.** Territory. Petroleum was thought likely, at one time, to become of great importance as a product of California, and several millions of dollars were expended in boring and searching for it, but almost entirely without success. The great bituminous slate formation, of Miocene age, which stretches along the coast from Monterey to Los Angeles, does, indeed, contain a large amount of combustible matter, which may at some future time become of economical value. At present there seems to be no immediate prospect of this; and it is certain that the geological conditions are such that flowing wells, like those of Pennsylvania, will not be found **Borax.** on the Pacific coast. Borax is one of the mineral productions of California, which is becoming of some importance. The value of the exports of this article from San Francisco in 1873 was over $400,000. Of this, however, a considerable portion came from the adjacent State of Nevada. Sulphur has been mined in several localities, to some extent, **Building stones.** for the manufacture of sulphuric acid. Marble occurs in many places in the Sierra Nevada, and is quarried for ordinary architectural purposes. Granite and freestone are abundantly distributed; the former exists in inexhaustible quantity on the line of the Central Pacific Railroad, the latter near San Francisco and in many other places in the Coast Ranges.

Mam[mals]. *Fauna.*—Somewhat over a hundred species of mammalia have been found in California. Among the most interesting are the grizzly bear (*Ursus horribilis*), formerly very common, but now only met with in out-of-the way localities; they are especially abundant in the Coast Ranges south of Monterey—the Santa Lucia Range. They are savage and powerful animals, but do not care to attack men unless suddenly intruded upon, or when with their young. The black bear (*U. americanus*) is still pretty common in the higher parts of the mountains; and the so-called cinnamon and brown bear are supposed to be varieties of this species. The sea lions (*Eumetopias stelleri*) are of little value commercially, but they excite a great deal of interest on account of their size, their strange gambols and extraordinary noises; they abound on the coast, and especially on the Farallones. Visitors to San Francisco from abroad rarely fail to go to the beach opposite Seal Rock, an isolated point near the city, and almost always crowded with these animals, whose curious habits can be watched from the mainland at a short distance. The beaver (*Castor canadensis*) was formerly very common in the State, and many are still left. The spermophiles, or ground squirrels, are extremely abundant, and great nuisances; the ground is often honey-combed for miles with their burrows. The large hare-squirrel and the tiny pine-squirrel are common in the mountains. Gophers are very troublesome to the farmers; there are five species of them, the largest (*Thomomys bulbivorus*) being abundant in the central portion of the State near the coast. The elk (*Cervus canadensis*), formerly found in great numbers in California, is now almost exterminated, unless it be in the northern counties, in the recesses of whose forests they may be still occasionally seen. The deer (*C. leucurus*) is quite common, at a distance from settlements, and especially in the southern High Sierra. A few antelopes are still met with; but when the Americans first entered California, these animals were seen in immense herds all over the plains of the San Joaquin and Sacramento valleys. The mountain sheep (*Ovis montana*) is also nearly exterminated. **Birds.** Of birds, over three hundred and fifty species have been described as occurring in California. Some of the most characteristic of this State are the road-runner (*Geococcyx californianus*), nearly allied to the cuckoo, but like a pheasant in its habits of running and inability to fly; the California woodpecker (*Melanerpes formicivorus*), which has the curious habit of boring holes in the bark of trees and filling them with acorns, which fit most accurately and closely in the cavities thus made. The object of this arrangement appears to be, to allow the grubs to fatten inside the acorns, which thus in time are found to contain a nice meal for the provident bird. The California vulture (*Cathartes californianus*), the largest flying bird in North America, is not limited to this State, but is common there. The sage hen (*Centrocercus urophasianus*) is a fine game bird, found in abundance on the east slope of the Sierra, among the "sage-brush." Two species of quail are very abundant, and very characteristic, in the State,—*Oreortyx pictus* and *Lophortyx californica*. They both have elegant crests of long narrow feathers, in one species turned backwards, in the other forwards. **Fishes.** Fish are very abundant on the coast; salmon are caught in great numbers in the Sacramento River, and are an important article of food, especially in Oregon. Sturgeon are also abundant: and as their flesh is sold at a very low price, it is much eaten by those who are obliged to be economical. The salmon is also in this respect a very valuable fish. The so-called "rock-fish" are among the fish most abundant in the San Fran-

cisco market, and perhaps the most characteristic. They belong to the genus *Sebastes*, and there are several species of different colours. Smelts are abundant; but they are not true smelts, and are inferior to them as an article of food. There are several fish of the flat-fish family, and called soles and turbot; although in no case are the species identical with those found on the Atlantic coast or in Euroope. The Tom-cod is abundant in the winter months, and although small, it is one of the best of the fishes of the coast. The barracouta (*Sphyræna argentea*) is decidedly the best-flavoured fish found on the coast; but it is not at all common. The oysters of the Californian coast are small; but foreign ones are planted in the Bay of San Francisco, where they grow rapidly. Hard-shell clams and mussels are abundant, and are eaten in considerable quantity. The haliotis called *Abelone* is taken in great numbers, but eaten exclusively by the Chinese. Crabs, lobsters, and shrimps, are abundant on the coast; and they are used to some extent as food. The variety of species of the crab family is very great, and some of them are very large. Quite serious attempts have been made, under the auspices of the United States Fish Commissioner, to introduce some of the eastern fishes into Californian waters, especially the shad; but these trials have not yet led to any satisfactory results.

Flora.—The vegetation of California has many features of interest The great extent of the State and the varied character of its surface are strongly impressed upon its flora. A great number of botanists and professional seed collectors have visited California from time to time; but no general review of all the species has ever been made, although such a one is now in progress under the auspices of the Geological Survey. The entire number of species found in the State is estimated at about 2500. There is not so great a variety of forest-trees as would naturally have been expected; and many of the most useful varieties are entirely wanting. The forests have, in places, and especially along the Sierra, at an elevation of from 2000 to 6000 or 7000 feet, a character of grandeur hardly surpassed in any part of the world. Many of the trees are of gigantic dimensions. Coniferous trees greatly predominate in the densely wooded portion of the State. Of the pines, the sugar pine (*Pinus Lambertiana*) is perhaps the finest tree, reaching occasionally 300 feet in height. Its wood is valuable for inside work, and it is much used in the Sierra, where the tree is chiefly found. This, and the *Pinus Coulteri*, have cones of great size. *Pinus sabiniana*, the digger pine or nut pine, is the characteristic tree of the foot-hills of the Sierra, where it occurs associated with the black oak (*Q. sonomensis*), sparsely scattered over the hill-sides, and never in dense forests. This is the foot-hill arboreal vegetation. Rising a litle higher, at an elevation of 3000 to 5000 feet, the pitch pine (*P. ponderosa*), the sugar pine, the white or bastard cedar (*Libocedrus decurrens*), and the Douglas spruce (*Abies Douglasii*) are the predominating and characteristic trees. Still higher, the firs come in, namely the *Picea grandis* and the *amabilis*, as well as the tamarack pine (*P. contorta*). This belt ranges at from 7000 to 9000 feet elevation in the Sierra, through the central portion of the State. The big tree (*Sequoia gigantea*) belongs to the same belt as the sugar pine, Douglas spruce, and pitch pine. This tree occurs in groves or patches from latitude 36° to 38° 15′, nowhere descending much below 4000 feet in elevation, or rising above 7000. There are eight or nine of these patches of big trees, and by far the largest is that one which extends along the tributaries of King's and Kaweah rivers, about thirty miles N.N.E. of Visalia. This belt is probably over ten miles in length. the trees are, however, not grouped by themselves, but stand scattered among other species. The tallest big tree yet discovered measures 352 feet in height. The circumference of the largest, near the ground sometimes reaches nearly 100 feet. Many are over fifty feet in circumference, at 6 feet above the ground. One in the Calaveras Grove, which was cut down, measured 24 feet and $1\frac{1}{2}$ inches in diameter, without the bark, at 6 feet above the ground; this would probably have measured about 27 feet with the bark. Its age was a little less than 1300 years. As the big tree is exclusively limited to California and to the Sierra Nevada, so the only other species of the same genus, the redwood (*S. sempervirens*), is peculiarly a Coast Range tree. It is found chiefly in the counties north of San Francisco Bay, where it forms magnificent forests, exclusively limited to this one species. A few of these trees may be found beyond the line dividing the State from Oregon; but this species, as well as the big tree, is peculiarly Californian. The wood, although brittle and splintery, is durable, and much used for building purposes in San Francisco. In size, this tree is very little inferior to the *Sequoia gigantea*. It appears that this species cannot thrive except where it is frequently visited by the ocean fogs. Another characteristic Coast Range tree is the California laurel (*Tetranthera californica*), which has a beautifully grained wood much valued for cabinet-work. Some species of Coniferous trees occurring in the Coast Ranges are very limited in their range; as, for instance, the well-known ornamental tree, the *Pinus insignis*, which is found near Monterey, and the Cypress (*Cupressus macrocarpa*), of which there is a magnificent grove at Cypress Point, near Carmelo Bay. The *Abies bracteata* is another of these trees of singularly limited distribution. The Douglas fir, or spruce, on the other hand, is spread over a vast area in California, Oregon, Washington Territory, and through the Rocky Mountains. Of shrubs, the manzanita (*Arctostaphylos pungens*) is a very characteristic one, being found all over the Sierra Nevada in dry places; the California buckeye (*Æsculus californica*) is another low-spreading tree or shrub, abundantly distributed through the Sierra and in the coast valleys; and another shrub, called by the Spanish the chamiso (*Adenostema fasciculata*), is widely scattered up and down the Sierra and Coast Ranges. The chamiso and the manzanita, with a variety of shrubby oaks and other thorny plants, when combined together in a dense and sometimes quite impenetrable undergrowth, form what is called by the Spanish a "chaparral." If the chamiso occurs alone, the thicket is known as a "chamisal." The oaks are very characteristic trees of the California Valley, to which they often give by their graceful grouping in isolated clumps a wonderfully park-like character. The burr oak (*Q. lobata*) is the most striking of these trees, growing to a great size, and having peculiar, gracefully-drooping branches. The elm, the hickory, the beech, the chestnut, and many other of the most characteristic and useful trees of the Eastern States, are entirely wanting in California. One valuable variety of the ash occurs, but only in limited numbers, and there is no species of maple which is suitable for use. Indeed, there is no wood on the Pacific coast from which any part of the running-gear of a good waggon can be made; consequently there is a large importation into the State, from the Atlantic side, of timber for this and similar purposes; while, on the other hand, the ornamental forest-trees of California are already widely spread over the world.

Agriculture.—The amount of land in California, which can properly be called tillable, cannot be stated with any approach to accuracy; and the estimates would vary, according as the peculiarities of the climate, and the possibilities of artificial irrigation, were taken into consideration. A large part of the State consists of barren deserts or precipitous mountains, either too rough or too

elevated, or too dry for cultivation under any circumstances. A considerable portion of the Great Valley will not yield sufficiently to pay for cultivation, unless a thorough system of irrigation should be adopted. Extensive districts produce valuable crops when the season has been wet enough; and an excess of rain which is injurious in one part of the State is of great benefit in another. The number of acres of "improved land" in the state, as given by the census of 1870, was 6,218,133; but Mr Hittell, in the third edition of his *Resources of California*, published in 1867, estimates the amount of cultivated land at only 1,000,000 acres. The same authority says, "Not more than one acre in ten could now be tilled profitably." Allowing the census returns to be correct, the proportion of improved land would be about one-eighteenth of the whole. Owing to the peculiarities of the climate, and especially its mildness in winter, and the dryness of the summer, the whole system of cultivation is very different in California from what it is in the Mississippi Valley and the Eastern States. If the season is favourable, that is, if rain falls in abundance by November, so that the ground becomes soft enough to plough, then sowing is begun at once, and the best crops are raised when the "latter rains,"—as they are usually called,—which fall in March and April, are tolerably abundant, and yet not so much so as to cause inundations. June and July are the harvest months, and the grain can remain out of doors during the whole summer without injury, or until it can be conveniently carried away, barns being little used. Almost everything, except ploughing, in connection with agricultural work, is done on a large scale, with the help of machinery; and the profitable farms are usually of great size, comprising many thousand acres. According to the census of 1870, the amount of the principal productions of the soil was in that year as follows:—wheat, 16,676,702 bushels; barley, 8,780,490 bushels; wool, 11,391,743 ℔; potatoes, 2,049,227 bushels; wine, 1,814,656 gallons; butter, 7,969,744 ℔. Barley is the most certain crop raised, and wheat and wool are the most important for exportation. The Californian wheat is of the finest quality, and is largely shipped to foreign countries. In 1873, according to the statistics of the San Francisco *Commercial Herald*, the shipments of wheat and flour were as follows:—to Great Britain, of flour, 245,708 barrels, and of wheat, 9,152,303 quintals; to China, flour, 125,891 barrels; to Central America, flour, 42,835 barrels; to Japan, flour, 9566 barrels; to Panama, flour, 12,777 barrels; to Australia, wheat, 22,400, bushels; with other smaller amounts to numerous ports in and about the Pacific. The total shipments for the years 1871–1873 were as follows:—

	Flour, barrels.	Wheat, quintals.	Barley, quintals.
1871	232,094	1,311,679	12,371
1872	247,088	6,071,383	176,153
1873	479,417	9,175,960	260,890

Fruit is an item of great importance in the agriculture of California, the quantity raised being very large, and the quality excellent. The pear, plum, apricot, and grape are especially good; and large quantities would be sent to the Eastern States if the distance were not such as to make it difficult and expensive to transport this bulky and perishable commodity. A large amount of capital has been invested in the manufacture of wine. As early as 1861 a million of gallons were made in that year, and in 1870 the product was estimated at 2,500,000 gallons. The principal wine-producing districts are in the vicinity of Sonoma, north of the Bay of San Francisco, and in the region about Los Angeles. The value of the exports of wine has not increased much in the last three or four years; in 1873 it was $356,373. The quantity of wine which might be produced in California, if there were a market for it, would be very large; but the quality is not all that could be desired, although the persons engaged in this business are sanguine in the belief that, with time and experience, the difficulties will be overcome, and their products be largely in demand in the Eastern States where at present there is scarcely any sale for them.

California is a country particularly adapted to raising sheep, and the wool interest is a very important one. The winters are so mild that shelter for the flocks is not required, and they have no other food than that which they pick up for themselves on the lower plains in winter, and in the higher mountain valleys in the summer. The summit valleys of the Sierra are literally alive with sheep during the months of July, August, and September, countless herds being driven there from the parched-up plains at the base of the range. In 1873, according to the *Commercial Herald*, about 30,000,000 ℔ of wool were exported from San Francisco, and 3 000 000 ℔ consumed in the home manufactories.

Manufactures.—The value of the manufactures of California is given, in the census report of 1870, at $66,594 536 the increase having been rapid within the past ten years; previous to 1860 almost every manufactured article used in the State was imported from the East or from Europe. The great distance of the Pacific coast from the manufacturing districts of the world offers a heavy premium for the establishment of various industries, especially for those which furnish bulky and inexpensive products, such as wooden wares, agricultural implements, machinery, coarse articles of clothing, and vehicles. The drawbacks are, the high price of labour, where the Chinese cannot be employed; the absence of good coal, and the scarcity of other fuel; the distance of the water-power from the principal markets, and its high cost at all points, which is due to the necessity of building long canals, dams, and other appliances for storing and utilizing the water; and the absence of those woods which are most needed for the innumerable uses to which this material is put in manufacturing. There are certain articles, however, which have to be made in California, because the people of other countries find it difficult to ascertain exactly what is needed to meet the requirements of the Pacific coast. Thus, mining machinery is a very important article of Californian manufacture, and many improvements have been made in this department, called out by the peculiar wants of this State and of Nevada. The manufacture of heavy woollen goods, especially blankets, is an item of importance, there being three large establishments of this kind in San Francisco. Leather is tanned in considerable quantity in the coast counties, and the exports of this article amounted in value, in 1872, to the sum of $258,692. Boots and shoes are manufactured in large quantity for home consumption and from native leather.

Population.—The population of California is concentrated in and around San Francisco; and it becomes rapidly less dense as one recedes from the centre. The extreme northern and southern counties are very thinly inhabited. The central part of the State, embraced between the parallels of 36° 20′ and 40° including only one-third of its whole area, contained in 1865 over ninety-five per cent. of the population. A region of 4000 square miles adjacent to the Bay of San Francisco includes probably half of the entire number of inhabitants in the State,—San Francisco alone, by the last census, having 38 per cent. of the whole. The reasons of this concentration around the bay are not difficult to find; the climate is more agreeable and healthier, and the valleys which open out to its waters are the most delightful and most fertile portions of the state. The desire of concentration is strongly felt in a region where the country is so thinly settled, and where the facilities

of communication are not great, and schools and churches far apart, or wanting altogether. Those who have made fortunes in mining come to "the Bay" to spend them; those who have lost their all, or become "strapped,"—to use the miner's phrase,—go to the great city to find employment. And San Francisco is not only the metropolis of California, but of the whole Pacific coast. There is not another city or town having one-tenth of its population anywhere from Alaska to Panama. It has the only really good harbour along the entire line of coast from Lower California north to Puget Sound, that of San Diego excepted, and this has a desert region behind it, where settlements cannot be made. The population of San Francisco, by the census of 1870, was 149,473, having increased to that number in the previous decade from 56,802, the gain of the city being relatively considerably greater than that of the State itself. Sacramento city, the capital, is the only other town in California which has as much as one-tenth of this number. It is claimed, indeed, that the present (1876) population of San Francisco is not less than 250,000, the increase having been unusually large during the past year, which has been, on the whole, a very prosperous one for the State. The other large towns are—Sacramento, 16,283; Oakland, 10,500; San Jose, 9089; Grass Valley, 7063; and Los Angeles, 5728,—all these figures being those of the census of 1870. The population of the whole State, according to the same authority, was, in 1870, 582,031, an increase of 53 per cent. since the previous census of 1860. The growth of California has not been in the years from 1860 to 1870 as rapid as in the decade preceding that, when the increase amounted to 310 per cent. Remarkable as has been the development of this State, it does not equal that of some of those of the Mississippi Valley during the same period. Thus Iowa gained more between the years 1860 and 1870 than did California, although having only one-third of the area of that State; and in the decade previous to that her gain was relatively nearly equal to that of the Golden State, and actually twice as great. The actual increase of population in Massachusetts, with its area of only 7800 square miles, was greater in the years 1860–1870 than was that of California.

The brilliant discoveries of metalliferous deposits in Nevada, wholly developed within the past fifteen years, have added much to the wealth and resources of California, for the ties of business are nearly as strong between the two States as if there were no political line of division between them. Nearly all the capital invested in the region at the eastern base of the Sierra came from the Pacific side of the mountains, and most of the machinery used there has been constructed in San Francisco. Nevada takes a large amount of the surplus agricultural products of California, and gives bullion in exchange, that being the only thing she produces for exportation.

The Chinese element in California is a peculiar and interesting feature. By the last census there were 49,31 of that race in the State. They are settled in great numbers in San Francisco, where they are house-servants, and operatives in the manufacturing establishments, which could not be successfully carried on with white labour. They also work the abandoned placers, although the amount of their gains in this operation must usually be very small, as they are only allowed to occupy spots supposed by the white men to have been quite worked out. "The white miners have a great dislike to Chinamen, who are frequently driven away from their claims, and expelled from districts by mobs. In such cases the officers of the law *do not* ordinarily interfere; and, no matter how much the unfortunate yellow men may be beaten or despoiled, the law does not attempt to restore them to their rights or avenge their wrongs" (Hittell, in *Resources of California*, 3d ed. p. 375).

General Considerations.—Finally, California has in its favour its immense extent of area, its variety of physical configuration, the fertility of a portion of its soil, and, above all, the mildness and attractiveness of its climate. Its position on the Pacific is one which justifies the confident expectation that the commercial interests of San Francisco will continue to increase in magnitude, since it must always concentrate the trade of an immense area. There are some conditions which may eventually operate powerfully to retard the development of this State. Of these the most important is, perhaps, the wastefulness of the present method of agriculture, by which crops are continually taken from the soil, and nothing restored to it. Another serious matter is the constant wholesale destruction of the forests going on in the Coast Ranges and in the Sierra; there is reason to fear that this will eventually have a disastrous effect on the regimen of the rivers, causing inundations in the spring and excessive droughts in summer. The danger from earthquakes has already been alluded to; and there is no question that it has had and will continue to have an influence in retarding the growth of the State, as there is not the least doubt that it similarly affects the whole South American Pacific coast. The facility with which the legislature can be manipulated, and brought to sanction schemes fraught with injury to the people, is not a circumstance peculiar to California; although, in several instances, heavy blows have in this way been struck at the prosperity of San Francisco. The distrust of the legislature often leads the people to reject that which is good, from the fear that an undertaking which looks well at the start may be so managed as to result in ruin. Thus, it seems impossible to carry out any general system of irrigation, or of forest culture and preservation, desirable as these things may be, because the people have no confidence in anything which has to be managed by the legislature, or which can be interfered with by that body at any time, and diverted to the subservience of private ends, to the injury of the public. (J. D. W.)

CALIGULA, Caius Cæsar, the third of the Roman emperors, was the son of Germanicus and Agrippina, and was born in 12 A.D. He was brought up in his father's camp among the soldiers, and received the name Caligula, from the *caligæ*, or foot-soldiers' shoes, which he used to wear. In 32 he was summoned to Tiberius, who was then living at Capreæ, and did all in his power to ingratiate himself with the tyrant. Perhaps about 35 he married his first wife, Junia Claudia, who died in the following year. Caligula seems then to have resolved upon obtaining the succession to the empire. For this purpose he leagued himself with Macro, commander of the prætorian guards, whose wife he had seduced, and there can be no doubt that the death of Tiberius was hastened by one or both of them. The senate conferred the imperial power upon Caligula alone, although Tiberius, the grandson of the preceding emperor, had been designated as co-heir, and he entered on his first consulship in July 37. For an account of his reign and character see Roman History.

CALIPH, or Khalif, the sovereign dignitary among the Mahometans, vested with an almost absolute authority in all matters relating to religion and civil polity. In the Arabic it signifies *successor* or vicar, the caliphs bearing the same relation to Mahomet that the popes, in

the estimation of Roman Catholics, bear to St Peter. It is at this day one of the titles of the grand seignior or sultan, who claims to be successor to Mahomet, through the line including Abu-Bekr, Oman, and Othman (the Sunnite view), and also of the Sophi or Sufi of Persia as claimant through Ali (the Shiite view). The history of the rule of the Sophis may occasionally remind the student of the saying current respecting Russian autocracy some fifty years ago, that it was "despotism tempered by assassination." When Louis XIV. was one day, in the presence of some courtiers, extolling the government of the Sophis as something approaching to an almost ideal excellence, the Marshal d'Estrees replied, "But, sire, I have seen three of them strangled during my lifetime." One of the chief functions of the caliph, in his quality of imaum or chief priest of Islamism, was to begin the public prayers every Friday in the chief mosque, and to deliver the *khootba* or sermon. In after times they had assistants for this latter office; but the former was always performed by the caliph in person. The caliph was also obliged to lead the pilgrims to Mecca in person, and to march at the head of the armies of his empire. He granted investiture to princes and sent swords, standards, gowns, and the like, as presents to princes of the Mahometan religion, who, though they had thrown off the yoke of the caliphate, held of it as vassals. The caliphs usually went to the mosque mounted on mules; and the Seljukian sultans, though masters of Baghdad, held their stirrups and led their mules by the bridle some distance on foot, till the caliphs gave them the sign to mount on horseback. At a window of the caliph's palace there always hung a piece of black velvet 20 cubits long, which reached to the ground, and was called the *caliph's sleeve;* this the grandees of his court kissed daily with great respect. After the destruction of the caliphate by Hulagu, the Mahometan princes appointed a particular officer in their respective dominions to sustain the sacred authority of caliph. In Turkey this officer is called *mufti*, and in Persia *sadne.*

The successions of caliphs continued from the death of Mahomet till the 655th year of the Hegira, when Baghdad was taken by the Tatars. After this, however, there were persons who claimed the caliphate, as pretending to be of the family of the Abbassides, and to them the sultans of Egypt rendered great honours at Cairo, as the true successors of Mahomet; but this honour was merely titular, and the right allowed them only in matters of religion; and though they bore the sovereign title of *caliphs*, they were subjects and dependents of the sultans. In the year of the Hegira 361, a kind of caliphate was erected by the Fatimites in Africa, and lasted till it was suppressed by Saladin. Historians also speak of a third caliphate in Yemen or Arabia Felix, erected by some princes of the family of the Jobites. The emperors of Marocco assume the title of *grand scherifs*, and pretend to be the true caliphs, or successors of Mahomet, though under another name. For particulars concerning the caliphs and caliphate see works bearing on Mahometan rule, such as Ockley's *History of the Saracens;* Gibbon's *Decline and Fall*, chap. li.; Von Hammer, *Histoire des Ottomans;* and for a brief survey, Freeman's *History and Conquests of the Saracens*, Oxford, 1856. See also articles ABBASSIDES and MAHOMETANISM.

CALISTHENICS. See GYMNASTICS.

CALITRI, a town of Italy, in the province of Principato Ulteriore and district of Sant' Angelo de' Lombardi, about 40 miles S.E. of Benevento. It is situated on an eminence near the River Ofanto, and is supposed to occupy the site of an ancient town called *Aletrium*. Its principal buildings are the parish church and a Benedictine convent. Population, 6629

CALIXTUS, the name of three different popes or bishops of Rome. Little is known of CALIXTUS I., bishop of Rome from about 220–226 A.D., during the reigns of Heliogabalus and Severus. CALIXTUS II., Guido of Vienne, was elected in 1119, after the death of Gelasius II. In 1122 he concluded with the Emperor Henry the important treaty of Mentz, by which the mutual rights of the church and the empire were definitely settled. He died in December 1124. CALIXTUS III., Alphonso de Borgia, was raised to the Papal chair in 1455 at a very advanced age. He was feeble and incompetent. The great object of his policy was the excitement of a crusade against the Turks, but he did not find the Christian princes responsive to his call. He died in 1458.

CALIXTUS, GEORGIUS (1586–1656), a celebrated Lutheran divine, born at Middleburg in Holstein in 1586. After studying at Helmstadt, Jena, Giessen, Tübingen, and Heidelberg, he had an opportunity of travelling through France and England, where he became acquainted with the leading Reformers, and saw the different forms which the Reformed church had assumed. On his return he was appointed professor of divinity at Helmstadt by the duke of Brunswick, who had admired his abilities in a contest which he had when a young man with the Jesuit Augustine Turrianus. After becoming a master of arts he published a book, *Disputationes de Præcipuis Religionis Christianæ Capitibus*, which provoked the hostile criticism of several learned men; and on his elevation to the professorship he published his *Epitome of Theology*, and soon after his *Epitome of Moral Theology*, which gave so great offence as to induce Statius Buscher to charge him with a secret leaning to Romanism. Scarcely had he refuted the accusation of Buscher, when, on account of his intimacy with the Reformed divines at the conference of Thorn, and his desire to unite them with the Lutherans, a new charge was preferred against him, principally at the instance of Calovius, of a secret attachment to Calvinism. The disputes to which this gave rise, known in the church as the Syncretistic controversy, lasted during the whole lifetime of Calixtus, and distracted the Lutheran Church, till a new controversy arose with Spener and the Pietists of Halle. Calixtus died in 1656. There is a monograph on Calixtus by Henke, 2 vols. 1853–56; see also Dorner, *Gesch. d. Protest. Theol.*, pp. 606–624.

CALLAO, the chief port of Peru, lies 8½ miles from Lima, the capital city, in 12° 4′ S. lat., 77° 13′ W. long. It is built on a flat point of land in the recess of a spacious and well-sheltered bay, which is partly enclosed by the islands of San Lorenzo and Fronton, and affords the best anchorage on the Peruvian coast. The modern town lies half a mile north of the site of an older city, destroyed by an earthquake and invasion of the sea in 1746. It consists mainly of houses built of wicker-work and plastered with mud, stronger buildings being dangerous from the frequency of earthquakes; but a walled quadrangular fortress, built by the Spanish Government between 1770 and 1775, extends over about 15 acres, and is now used for the custom-house offices and stores. There are also several forts mounting cannon, and among the public buildings are the military and naval Government offices and barracks, three Catholic churches and a Protestant chapel, two clubs, a hospital, and four banks. Several newspapers are published in the town. Callao is the headquarters of the Pacific Steam Navigation Company in South America (incorporated in 1840), and the works in connection with their large fleet of steam-vessels—foundries, carpenters' shops, flour-mills, bakeries, and gas-works—occupy a large area near the custom-house. A large steam sugar-refinery is also in operation. Harbour works, consisting of sea walls of concrete blocks, and docks, with

berthing space for thirty large vessels, begun in 1871, were completed in February 1875, superseding the old and inconvenient pier and boat harbour. These works comprise also eighteen steam-cranes for loading goods, a triple line of railway along the dock walls, gas illumination, and supplies of fresh water. A floating dock, 300 feet in length, capable of taking up a vessel of 21 feet draught, and 5000 tons weight, was built in Glasgow and sent out to Callao harbour in 1863. The phenomenon of the bubbling up of sulphuretted hydrogen gas in the harbour, known as "Callao painter," from its action on the paint of ships, has generally been ascribed to volcanic action, the belief having been that Callao is in the crater of an extinct volcano; but the borings for the new works discovered the cause of this to be in strongly impregnated springs forcing their way up through a stratum of clay and mud. Callao communicates with Lima by carriage road, and by a railway, completed in 1852, which is now extended through the capital towards Oroya over the Maritime Andes. The Pacific Company despatches or receives an ocean steamer almost every week to or from Liverpool by Valparaiso, the Strait of Magellan, and Rio de Janeiro; a separate bi-weekly steam line unites the port with Valparaiso, and communication is maintained with Panama by steamers four times a month each way. French and German steam lines have also headquarters at Callao. Trade is carried on mainly with Britain, the United States, France, Italy, Germany, Norway, and Central America, an average of nearly 2000 vessels entering the harbour annually, and frequently clearing in ballast for the Guano Islands, although exportation from the former main source of supply of guano —the Chincha Islands—ceased in 1872. This substance continues to be the most valuable export; after it come sugar, cotton, wool, hides, silver, and gold. Callao imports timber and railway material, wheat, ice, cattle, coal, and mixed cargoes of manufactures from foreign countries, and considerable quantities of flour from Chili. The whole value of imports and exports exceeds £6,000,000 annually. Since 1850, with the exception of the years between 1856 and 1861, when the immigration was prohibited by Congress, Chinese coolies have been imported in considerable numbers through Callao from the Portuguese possession of Macao in China. Perhaps 100,000 male Chinese have been introduced under contracts to serve for eight years; the passages have too often been attended with great hardships and frightful mortality, but the Chinese prove valuable workers on the great railroads now constructing in Peru.

Though the climate of Callao is good, having the pure breeze from the Pacific, and a temperature rarely exceeding 77° or falling below 65° Fahr., yet, in the absence of all hygiene, diseases, such as fevers and smallpox, are very prevalent, and the rate of mortality is high. The population, in default of recent exact enumeration, may be taken at from 15,000 to 18,000; the census of 1866, the latest, gave 14,800, a decrease of upwards of 2000 in seven years, and the number was further reduced by the havoc made by yellow fever in 1868. The traffic and business, and with these probably the population, of the port are, however, increasing.

CALLCOTT, Sir Augustus Wall (1779-1844), Knt., R.A., one of the most distinguished of English landscape painters, was born at Kensington in 1779, and died there in 1844. His first study was music; and he sang for several years in the choir of Westminster Abbey. But at the age of twenty he had determined to give up music, and had exhibited his first painting at the Royal Academy. He gradually rose to distinction, and was elected an associate in 1807 and an academician in 1810. In 1827 he received the honour of knighthood; and, seven years later, was appointed surveyor of the royal pictures. His two principal subject pictures—Raphael and the Fornarina, and Milton dictating to his Daughters, are much inferior to his landscapes, which are placed in the highest class by their refined taste and quiet beauty. Callcott always chose to paint nature in her lovely and placid aspect; and has therefore been called the English Claude.

CALLCOTT, John Wall (1766-1821), brother of the preceding, was born at Kensington in 1766, and was the son of a builder. At the age of seven he was sent to a neighbouring day school, where he continued for five years, studying chiefly Latin and Greek. During this time he frequently went to Kensington church, in the repairs of which his father was employed, and the impression he received on hearing the organ of that church seems to have roused his love for music. The organist at that time was Henry Whitney, from whom Callcott received his first musical instruction. He did not, however, choose music as a profession, being desirous to become a surgeon, only when on witnessing a surgical operation he found his nervous system seriously affected by the sight, he determined to devote himself to music. His intimacy with Dr Arnold and other leading musicians of the day procured him access to artistic circles; and his successful competition for the prize offered by a musical society called the "Catch Club" soon spread his reputation as composer of glees, catches, canons, and other pieces of concerted vocal music. On these his reputation as a creative musician is mainly founded. In them he displays considerable skill and talent, and some of his glees retain their popularity at the present day. They are well adapted to the voice, and their melodies are pleasing and not without feeling. As an instrumental composer Callcott never succeeded, not even after he had taken lessons from Haydn. But of far greater importance than his compositions are his theoretical writings, and it is chiefly for the sake of the latter that he is noteworthy beyond other English composers of equal merit. His *Musical Grammar*, published in 1806 (3d edition, 1817), was long considered as the standard work of musical instruction in this country, and has not been superseded up to the present day by any other book produced by an English musician. It is a scholarly and lucid treatment of the rudiments of the art, but at present, of course, antiquated to a great extent, and, indeed, all but useless to the student of modern music. Callcott was a much esteemed teacher of music for many years. He also held the position of organist at various churches. In 1800 he took his degree of Mus. D. at Oxford, and in 1805 he succeeded Dr Crotch as musical lecturer at the Royal Institution. Towards the end of his life his artistic career was frequently interrupted by ill-health. He died, after much suffering, in 1821. A posthumous collection of his most favourite vocal pieces was published with a memoir of his life by his son-in-law, Mr W. Horsley, himself a composer of note. Numerous other works remain in manuscript.

CALLCOTT, Mrs Maria Graham (1786-1844), daughter of Admiral Dundas, became the wife of Sir Augustus Callcott in 1827. With her first husband, Capt. Graham, R.N., she travelled in India, South Africa, and South America, where she acted for some time as teacher of Donna Maria, who became queen of Portugal in 1826; and in the company of her second husband she spent much time in the south of Europe. She published accounts of her visits to India (1812), and to the environs of Rome (1820); *Memoirs of Poussin* (1820); a *History of France*; a *History of Spain* (1828); *Essays toward a History of Painting* (1836); *Little Arthur's History of England* (1836); and the *Scripture Herbal* (1842).

CALLIMACHUS, a celebrated Greek poet, was a native of Cyrene, and a descendant of the illustrious house of

the Battiadæ, whence by Ovid and others he is called Battiades. He flourished under Ptolemies Philadelphus and Euergetes, and probably succeeded Zenodotus as chief librarian of the famous Alexandrian library, an office he held from about 260 B.C. till his death, which took place about 240 B.C. He was regarded, according to Quintilian, as the prince of Greek elegiac poets. His style is elegant and nervous, yet his excellences are rather the result of excessive elaboration than of genuine poetic power: hence Ovid (*Am.*, i. 15) says of him—*Quamvis ingenio non valet, arte valet.* Perhaps the *Hymn to Apollo* should be excepted from this criticism. Callimachus was a learned critic and grammarian, and the instructor of Eratosthenes, Aristophanes of Byzantium, and Apollonius Rhodius. He wrote in prose and in verse on a great variety of subjects; but his only existing works are six hymns, seventy-three epigrams, and some fragments of elegies. Of the various imitations of Callimachus by the Roman poets, the small poem by Catullus, *De coma Berenices*, is the most celebrated.

Among the numerous editions of his works the following may be noticed:—By Grævius with Spanheim's Commentary, Utrecht, 1697; by Ernesti, Leyden, 1761; by Bloomfield, Lond., 1815; by Volzer, Lips. 1817; *Fragmenta*, by Næke, 1844; *Hymni et Epigrammata*, by Meineke, 1861; *Callimachea*, by Schneider,—i. (*Hymni*), 1870, ii., 1847.

CALLIMACHUS, an architect and statuary, the inventor of the Corinthian column, was probably a native of Corinth. He is said to have derived the idea of the Corinthian capital from observing an acanthus plant surrounding a tile-covered basket which had been placed over a tomb. His era is uncertain; but as the Corinthian column was used in 396 B.C., by Scopas, the architect of the temple of Athena Alea at Tegea, he must have lived before that time. Though Callimachus worked admirably in marble he is said to have spoiled his original conceptions by excessive elaboration, which rendered his style artificial. (Plin., *N. H.*, xxxiv. 8, s. 19.)

CALLIOPE, the muse of epic poetry. She was so named from the sweetness of her voice, and was the last of the nine sisters. Her distinguishing office was to record heroic actions; and she is represented with a tablet and style, or a roll of paper in her hand. See MUSES.

CALLIRRHOE, in Greek legend, was a daughter of the river god Achelous, and became the wife of Alcmæon, who had wandered from Argos to be purified in the water of the Achelous from the crime of having killed his mother Eriphyle. He had taken with him from Argos the ill-omened necklace and *peplos* of Harmonia, with which his mother had been misled by Polynices, but he had left them in Arcadia. Callirrhoe pressed so hard to obtain them that he was compelled to go for that purpose to Phegeus, the king of Psophis in Arcadia, with whom he had left them. While returning he was waylaid by Phegeus and killed. Callirrhoe now implored the gods to cause her two young sons to grow at once to manhood to avenge their father's death. This was granted, and her sons slew Phegeus with his two sons, and returning with the necklace and *peplos*, dedicated them at Delphi.

CALLISTHENES, a philosopher of Olynthus, and a relation and pupil of Aristotle, through whose recommendation he was appointed to attend Alexander in his Asiatic expedition, 334 B.C. He had the imprudence to censure the conqueror's adoption of Oriental customs, inveighing especially against the servile ceremony of adoration. Having by the boldness of his censures rendered himself highly obnoxious to the king, he was accused of being privy to a treasonable conspiracy; and after being kept in chains for seven months he died, either by torture, or of a disease arising from excessive obesity. Callisthenes wrote an account of Alexander's expedition, a history of Greece, and other works, all of which have perished.

CALLISTO, in Greek Mythology, an Arcadian nymph, who was transformed into a bear as a penalty for having born to Zeus a son, Arcas, from whom the Arcadians, or bear-people, derived their name (Ovid, *Metam.*, ii. 468, *fol.*) Arcas, when hunting, encountered the bear Callisto, and would have shot her, had not Zeus with swift wind carried up both to the skies, where he placed them as a constellation. Artemis, as goddess of hunting, was styled Callisto in Arcadia, and had the symbol of a bear.

CALLISTRATUS, an Athenian orator, whose eloquence made such an impression on Demosthenes that he resolved to devote himself to oratory. On account of the surrender of Oropus to the Thebans Callistratus, despite his magnificent defence, was condemned to death, 361 B.C. He fled to Methone in Macedonia, where it is said he founded the city of Datum, afterwards Philippi. Having returned to Athens, he was put to death.

CALLISTRATUS, an Athenian poet, whose works have nearly all perished. He is now only known as the author of the hymn in honour of Harmodius and Aristogiton, who fell in their attempt to put down the dynasty of the Pisistratidæ at Athens. This ode, which is contained in Athenæus, has been beautifully translated by Thomas Moore.

CALLOT, JACQUES (1593–1635), a French engraver, was born in 1593 at Nancy in Lorraine, where his father was a herald at arms. He early discovered a very strong predilection for art, and at the age of twelve quitted home without his father's consent, and set out for Rome, where he intended to prosecute his studies. Being utterly destitute of funds he joined a troop of Bohemians, and arrived in their company at Florence. In this city he had the good fortune to attract the notice of a gentleman of the court, who supplied him with the means of study; but he removed in a short time to Rome, where, however, he was recognized by some relatives, who immediately compelled him to return home. Two years after this, and when only fourteen years old, he again left France contrary to the wishes of his friends, and reached Turin before he was overtaken by his elder brother, who had been despatched in quest of him. As his enthusiasm for art remained undiminished after these disappointments, he was at last allowed to accompany the duke of Lorraine's envoy to the Papal court. His first care was to study the art of design, of which in a short time he became a perfect master. Philip Thomasin instructed him in the use of the graver, which, however, he ultimately abandoned, substituting the point as better adapted for his purposes. From Rome he went to Florence, where he remained till the death of Cosmo II., the Mæcenas of these times. On returning to his native country he was warmly received by the then duke of Lorraine, who admired and encouraged him. As his fame was now spread abroad in various countries of Europe, many distinguished persons gave him commissions to execute. By the Infanta Isabella, sovereign of the Low Countries, he was commissioned to engrave a design of the siege of Breda; and at the request of Louis XIII. he designed the siege of Rochelle, and the attack on the Isle of Ré. When, however, in 1631, he was desired by that monarch to execute an engraving of the siege of Nancy, which he had just taken, Callot refused, saying, "I would rather cut off my thumb than do anything against the honour of my prince and of my country;" to which Louis replied—that the duke of Lorraine was happy in possessing such subjects as Callot. Shortly after this he returned to his native place, from which the king failed to allure him with the offer of a handsome pension. He died in 1635 at the age of forty-two. He engraved in all about 1600 pieces,

the best of which are those executed in aquafortis. No one ever possessed in a higher degree the talent for grouping a large number of figures in a small space, and of representing with two or three bold strokes the expression, action, and peculiar features of each individual. Freedom, variety, and *naïveté* characterize all his pieces. His Fairs, his Miseries of War, his Sieges, his Temptation of St Anthony, and his Conversion of St Paul will be sought after and admired as long as there are artists to learn and a public to appreciate.

CALMAR, or KALMAR, the capital of a province of the same name in Sweden, on Calmar Sound opposite the island of Öland, about 190 miles from Stockholm, in 56° 40′ N. lat., 16° 20′ E. long. It is built on the island of Quarnholm, and communicates with the suburbs on the mainland by a bridge of boats. Most of the houses are built of wood; but the cathedral, erected in the 17th century by Nicodemus Tessin the younger, the castle, the town-house, and other public edifices are of stone, of which there are good quarries in the island of Öland. It has a gymnasium, and several smaller educational establishments. The harbour is safe and commodious, but a large part of the trade has been transferred to Stockholm. Besides its manufactures of woollen stuffs, leather, tobacco, and potash, the town carries on shipbuilding and an export trade in flax, timber, iron, alum, pitch, &c. Calmar was once a flourishing and strongly-fortified town; and, previous to the conflagration of 1647, was built on the mainland. It is frequently mentioned both in the military and political annals of Sweden, and especially gives name to the treaty by which Sweden, Denmark, and Norway were, in 1397, erected into one kingdom under Queen Margaret. Population in 1868, 9420.

CALMET, DOM AUGUSTINE (1672–1757), a scholar and Biblical critic, born at Mesnil-la-Horgne in Lorraine, in 1672. In his fifteenth year he went to the university of Pont-a-Mousson, which he attended for a single session. In 1688 he joined the Benedictines at the abbey of St Mansin, into whose order he was publicly received in the following year. His theological and philosophical studies he completed at the abbey of Munster, to which he was sent in 1704 with the rank of sub-prior. He here organized an academy of eight or ten monks, the sole business of whose life was to assist him in preparing his *Commentary on the Bible*. The publication of this voluminous work, begun in 1707, was not completed till 1716. Two years after this latter date he was rewarded for his services with a presentation to the abbey of St Leopold at Nancy, and ten years after to that of Sénones, where he died in 1757. His attachment to his country and congregation was such, that he refused a bishopric *in partibus* offered to him by Pope Benedict XIII. Besides his *Commentary*, he wrote many other works, of which the most important are his *Histoire de l'Ancien et du Nouveau Testament*, an introduction to the *Ecclesiastical History of Fleury*; *Dictionnaire historique, critique, et chronologique de la Bible*, an extremely learned, but by no means judicious work; and *Histoire universelle sacrée et profane*, 15 vols. 4to. The *Dictionary of the Bible* has been translated into English, and is a well-known work.

CALMUCKS, KALMUCKS, or KALMUIKS, a people of Mongolian race who inhabit various parts of the Russian and Chinese empires, as well as other portions of Central Asia. They are of the middle height, fairly proportioned, and of considerable strength; their cheek-bones are prominent, the chin short, the nose turned up, the beard thin, and the hair scrubby. For the most part still in the nomadic stage, they inhabit conical felt tents, which they set up in regular lines like the streets of a town. Their wealth consists entirely in small but high-spirited horses, excellent cattle, and broad-tailed, rough-fleeced sheep. They are so much addicted to gaming that they not unfrequently stake everything they possess. In religion they are adherents of Lamaism, and their conduct is greatly under the control of their priests. Their language is closely connected with Mongolian proper, and is written with a similar alphabet; its grammar and vocabulary have been made known to Europeans more especially by A. H. Zwick about 1853. Of their literature the great proportion is religious, and is derived from Indian originals. The *Siddhi Kür*, a collection of stories, which is one of their most famous productions, was published with a German translation, a glossary, and notes, by B. Jülg, at Leipsic in 1866. As early as the 16th century the Calmucks possessed an extensive district of Central Asia between the Altai mountains and the Thian Shan, and between the desert of Gobi and the Balkash or Tengis Lake; and they were also settled in what is now the southern part of the Yeniseisk government, where indeed they were first met by Russian emigrants. At that time they bore the name of Derben Oirat, or Four Confederates, being divided into the four tribes of Jungars, Turguts, Khoshots, and Durbots. In the 17th century the Calmucks grew extremely strong, and after violent feuds united themselves, under the leadership of Batur and his son Galdan, into the powerful Jungarian kingdom. The strife which preceded the unification occasioned important movements of some Calmuck bands towards the E. and S.E. of Russia. Under Kourliuk, the great mass of the Turguts appeared for the first time within the Russian territory on the eastern side of the Volga in 1630. They conquered the nomadic Nogais of the district, but on this first occasion turned back to the Kirghiz steppes. In 1636 as many as 50,000 *kibitkas* or more than 200,000 men and women crossed the Emba, and took possession of the Trans-Volga steppes of the present Astrakhan government; and plundering incursions began to be made on the Russian settlements, in Saratoff, Penza, and Tamboff, while Tobolsk, in Siberia, had to defend itself with arms in 1646. After the fall of Kourliuk, in an attack on Astrakhan itself, the Calmucks became less aggressive, and in 1655 passed of their own accord under Russian authority. Down to the middle of the 18th century bands, however, continued to arrive, and the depredations on Russian ground did not cease during all the long reign of the Khan Ayuka (1670–1724). This chief more than once broke his oath to the Russian Government; but he also on several occasions supplied very important contingents to the imperial army. His power is shown by the fact that his court was visited in 1713 by an ambassador from China. In the reign of the Empress Catharine the Russian Government created great discontent among the Calmucks by their general treatment, and still more by refusing to confirm Ubashi, the grandson of Ayuka, in his dignities. A Calmuck chieftain from Jungaria skilfully took advantage of this condition of affairs to persuade Ubashi and his subjects to return to Jungaria, and attempt its conquest. The result was the wonderful and disastrous flight of the Calmucks from Russia in 1771, so graphically described by De Quincey. The number of the fugitives amounted, according to some authorities, to 120,000. Harassed on all sides by savage troops of Cossacks and Khirghises, the wretched Calmucks pursued their way across the barren steppes, and their main body was routed in a terrible battle on the shores of the Balkash. The remnants were settled on the banks of the Ili by the Chinese emperor Kien Long, and there their descendants are still to be found. There still remained in Russia the Durbots, who were living in the Don territory, and those of the Astrakhan Calmucks who at the time of the flight happened to be on the right bank of the Volga.

The total number now in the Russian empire may be estimated at 120,000. In the Chinese territory, where they are known as Eliots, or Olüts, their numbers are considerable, but are not precisely known.

See Pallas, *Mongolische Völkerschaften*, 1776-1802; Bergmann, *Nomadische Streifereien unter den Kalmücken*; Helmersen, *Der Telezkische See und die Teleuten in östl. Altai*, 1838, Quatremère, "Observ. géogr. et hist. sur les Calmouks," in *Journ. des Savants*, 1839; Hommaire de Hell, *Les steppes de la mer Caspienne*, 1843; Tchihatcheff, *Voyage d'Altai*, 1846; Semenoff, *Slovar Ross. Imp.*

CALNE, a town of England, in the county of Wiltshire, connected with the Great Western railway system by a branch line opened in 1863, and situated about 16 miles directly east of Bath. It stands in a valley intersected by the little brook of Calne, and is surrounded by the high table-land of Marlborough Downs and Salisbury Plain. The town is clean and well paved, and contains an ancient church (St Mark's) with a tower by Inigo Jones, and a town-house considerably enlarged by the marquis of Lansdowne, whose seat of Bowood is about two miles distant. The educational establishments include Bentley's grammar school founded in 1660, national and infant schools, and an institution for training female servants, which was endowed by Mrs Guthrie, to whom the town is also indebted for a children's hospital. The principal trade of Calne is the curing of bacon; and there are also flax-mills, paper-mills, and flour-mills in operation. The manufacture of broad cloth, at one time of great importance, is almost extinct. Calne formerly returned two members to parliament, but the number is now reduced to one. Population of the municipal borough in 1871, 2468, and of the parliamentary, 5315. From the remains found in the vicinity, Calne seems to have been an important Roman station. It was the occasional residence of the West Saxon kings; and is celebrated in legendary ecclesiastical history for the escape of Dunstan at the synod held there in 997.

CALOMEL, mercurous chloride, or subchloride of mercury (HgCl), is a compound of mercury of great value in medicine. It occurs native as horn quicksilver in the mercury mines of Idria, at Obermoschel, in Bavaria, Horowitz in Bohemia, and Almaden in Spain, in the form of translucent tetragonal crystals, with an adamantine lustre, and a dirty white grey or brownish colour.

A great number of processes are available for the preparation of calomel for pharmaceutical purposes. The directions of the *British Pharmacopœia* are as follows:—Sulphate of mercury 10 oz., mercury 7 oz., common salt 5 oz., and boiling distilled water. The sulphate of mercury is to be moistened with part of the water, and it and the mercury rubbed up together until all metallic globules disappear. The salt is then added, and the whole thoroughly triturated, after which it is sublimed in a vessel of such capacity that the calomel, instead of forming a crystalline crust on the sides as it would do in a vessel of small dimensions, shall fall in the form of a fine impalpable powder on the floor of the receiver. The sublimate is to be washed until the washings cease to be darkened on the addition of a drop of sulphide of ammonium. The reaction in the above case may be represented thus:

$$HgSO_4 + Hg + 2NaCl = Na_2SO_4 + 2HgCl\,.$$

After thorough washing the calomel has to be dried at a temperature not exceeding 212° Fahr., and preserved in a jar away from the light, exposure to which darkens it by partial decomposition into corrosive sublimate $HgCl_2$ and metallic mercury. Calomel when so prepared is a dull, heavy, white, nearly tasteless powder, which is rendered yellowish by trituration in a mortar or when heated. It is entirely insoluble in water, alcohol, or ether, and volatilizes, below a red heat, without fusion. When sublimed in a confined chamber it forms a crust or cake, the inner surface of which is covered with crystals in fine quadrangular prisms, having a transparent dirty-white appearance.

Calomel is one of the mildest and most frequently employed of all mercurial preparations, producing its effects with little local irritation. It exercises a powerful influence on the secreting organs, stimulating the liver and intestinal glands to increased activity, on which account it is much relied on in cases of functional derangement of the liver. It is usually combined with other remedial agents, each exercising an influence in modifying the effect or increasing the activity of the other. Thus as a purgative it is combined with jalap, scammony, colocynth, and other similar substances. The much used Plummer's pill, which is essentially the same as the compound calomel pill of the *British Pharmacopœia*, contains in addition to calomel an equal weight of oxysulphide of antimony, with guaiacum and castor oil. It is employed both in Europe and America as an alterative in chronic skin diseases, in liver affections, and in disorders of the digestive system. On account of its tastelessness calomel is a convenient aperient for children, who however appear to be less susceptible to its effects than adults. It has been used in very large doses in the treatment of cholera; and it is a convenient medium for producing salivation. Suspended in gum or glycerine water it has been used for hypodermic injection; and in the form of an ointment it is one of the most useful of external applications in the case of obstinate skin diseases.

CALONNE, Charles Alexandre de (1734–1802), a French statesman, was born at Douai in 1734. He was descended from a good family and entered the profession of the law, in which he rapidly attained success. He became in succession advocate to the general council of Artois, *procureur* to the parliament of Douai, and finally master of requests, a dignity which gave him the right of sitting in the general council. He seems to have been a man of great business capacity, gay and careless in temperament, and thoroughly unscrupulous in political action. In the terrible crisis of affairs preceding the French Revolution, when minister after minister tried in vain to replenish the exhausted royal treasury and was dismissed for want of success, Calonne was summoned to take the general control of affairs. He assumed office in 1783, and at first everything seemed to prosper. Money flowed in readily, and the gaiety of the minister gave courage to the court. But his prosperity was hollow and rested on no secure foundation. Calonne had levied taxes until it was impossible to extract more from the impoverished people. He had borrowed till his credit was entirely gone, and he at last found himself compelled to disclose to the king the true state of affairs, and to lay before him what in his opinion was the only measure that could restore France. The first step in this proposed plan was the convocation of the notables, and the writs summoning them were issued in December 1786. On the 22d February of the following year Calonne disclosed to the notables his anxiously expected scheme for reconstituting the finances. The main provisions of this plan were the redistribution of the taxes, so that the whole might not fall on the unprivileged classes, the imposition of a land tax on the revenues of the nobles, and of a similar tax on the incomes of the clergy, and the abolition of *corvées* and the *gabelle*. All Calonne's eloquence could not succeed in rendering this scheme palatable either to the notables or to the people. The noblesse and clergy strenuously resisted any attempt to infringe upon their privileges, and the people were beginning to feel that in a convocation assembled to settle the affairs of France the nation itself had no part. Calonne had opened the floodgates, and was powerless to resist the torrent. His fall, however, was primarily due to the

indignation of the court. He was dismissed from office in April, and exiled to Lorraine. Soon afterwards he passed over to England, and during his residence there kept up a polemical correspondence with Necker on the finances. In 1789, when the States-General were about to assemble, he crossed over to Flanders in the hope of being allowed to offer himself for election, but he was sternly forbidden to enter France. In revenge he joined the Bourbon party at Coblentz, wrote in their favour, and expended nearly all the fortune brought him by his wife, a wealthy widow. In 1802, having again taken up his abode in London, he received permission from Napoleon to return to France. He died 30th October 1802, about a month after his arrival in his native country. Calonne was the author of several works on the financial and political condition of France during the period of the Revolution, which are still of value.

CALPURNIUS, Titus, a Roman bucolic poet, under whose name eleven eclogues have been transmitted to us, is interesting as the first imitator of Virgil in pastoral poetry, and from the controversy respecting his date. His eclogues usually occur in MS. along with the *Cynegeticon* of Nemesianus, who undoubtedly flourished under Carinus (284 A.D.), and hence he has been generally referred to the same epoch. This view is expressed in a famous passage of Gibbon (ch. xii.), where Calpurnius is cited as an authority for the spectacles exhibited with unusual splendour by Carinus. Gustavus Sarpe, in an ingenious disquisition published in 1819, first maintained that Calpurnius had lived as early as the reign of Nero; his arguments have been repeated and greatly fortified by Moritz Haupt (1854), and have convinced the most recent authorities, Teuffel, the latest and most accurate historian of Latin literature, and Mr Pinder. This thesis would indeed be untenable if the last four eclogues could be ascribed to Calpurnius, as they contain manifest imitations of Statius. Haupt, however, seems to have proved from internal evidence that they are the work of Nemesianus. Upon attentive consideration, however, it appears to the present writer that Calpurnius cannot have written either under Nero or under Carinus. 1. The first eclogue is indirectly dedicated to a sovereign, complimented as the auspicious successor of a lawless tyrant, by whom a large proportion of the senate had been executed or imprisoned (ver. 60–62, 69–73). This censure is inapplicable to Carus, and the compliment could in no case have been addressed to his son and successor Carinus. It is almost equally inappropriate to Nero's predecessor, Claudius, who was popular with the senate (Suet. *in Claudio*, 12, 46). 2. The accession of the new emperor is hailed as the termination of war (*Ecl.* i. ver. 46–50) and the harbinger of a durable peace (i. 54; iv. 127, 131, and other passages). But Nero's accession took place at a period of profound peace, and Carinus's at one of extensive foreign hostilities. 3. Carinus cannot have been intended, inasmuch as no mention is made of his own or his father's military renown or of the association of his brother in the empire; nor can he have been represented as favourable to the senate, which he notoriously detested (Vopiscus *in Carino*, c. 17). If, on the other hand, the poet had written to celebrate the accession of Nero, he would not have omitted to celebrate the then omnipotent Agrippina. 4. Calpurnius's description of the games in the amphitheatre (*Ecl.* 7) differs from the account of Vopiscus in the Augustan history,—whatever is especially celebrated by the one being omitted by the other. Calpurnius dwells wholly on the zoological, Vopiscus on the musical and dramatic features of the entertainment; the former has not a word to say on the *nova spectacula* indicated by the latter as the distinguishing features of the show—the thousand pantomimists, the four hundred performers on wind instruments, the [illegible] *agentes*. It may also be remarked that Calpu[illegible] of the amphitheatre as looking down upon th[illegible] rock, which, according to the preferable opini[illegible] the opposite side of the Capitoline hill to th[illegible] Martius, where the games were exhibited by N[illegible] *in Nerone*, 12).

It remains, therefore, to discover an emperor to the panegyric of Calpurnius can apply, whose pred[illegible] should have been a scourge to his subjects in gen[illegible] to the senate in particular, and whose own accession early age should have been hailed as a pledge of p[illegible] tranquillity—one, moreover, who should have exhi[illegible] public spectacles in the amphitheatre. All these cond[illegible] are fulfilled by Gordian III., whose accession at the of thirteen or sixteen (238 A.D.) closed a series of civil [illegible] and revolts which had proved fatal to six emperors, w[illegible] the character of Maximin, virtually his immediate [illegible] cessor, entirely corresponds to the description of [illegible] purnius. Maximin's ferocity had been chiefly indulged the expense of the senate (Capitolinus, *passim*), and [illegible] public relief at Gordian's accession is significantly expr[illegible] by the great preponderance of inscriptions celebrating tranquillity, of which he was regarded as the harbing[illegible] among the legends of the medals struck during his reig[illegible] Other medals attest the fact of his having exhibited wi[illegible] beasts in the Flavian amphitheatre (Gori, vol. iii. p 115–121). It may be added that the imperial favouri[illegible] upon whose patronage Calpurnius relies may be plausib[illegible] identified with Timesitheus, Gordian's virtuous minister a[illegible] father-in-law; and that the mention (*Ecl.* i. 77–78) of t[illegible] comet which signalized the succession of the prince [illegible] illustrated by the appearance of a comet in China, whi[illegible] would probably be visible in Italy, in September 238, thr[illegible] months after Gordian's proclamation as sole emper[illegible] (Williams, *Chinese Observations of Comets*, p. 21.) Th[illegible] comet continued visible in China for forty-one da[illegible] Calpurnius's statement that it had been conspicuous f[illegible] twenty days when he wrote enables us, if our hypothe[illegible] be correct, to indicate the date of his literary *début* wi[illegible] remarkable precision.

In this case Calpurnius is not strictly entitled to th[illegible] distinction of having led the way in the bucolic imitation of Virgil,—fragments of two anonymous eclogues having been recently discovered and published which undoubtedly belong to the age of Nero. He is, however, Virgil's first follower of any mark, and no important modification has been introduced into his treatment. He is unquestionably a skilful literary craftsman, a fair scholar and an apt courtier, and not devoid of real poetical feeling. The bastard style of pastoral cultivated by him, in which the description of nature is made the writer's pretext, while ingenious flattery is his real purpose, nevertheless excludes genuine pleasure, and consequently genuine poetical achievement. He may be fairly compared to the minor poets of the reign of Anne. No biographical particulars respecting him are known except his complaints of his poverty.

Calpurnius was first printed in 1471, together with Silius Italicus. He has been frequently republished, generally in company with Gratius and Nemesianus. The best edition is in vol. ii. of Wernsdorf's *Poetæ Latini Minores*. The most recent is that by Glaeser, Göttingen, 1842. (R. G.)

CALTAGIRONE, or Calatagirone, a town of Sicily, the seat of a bishop, in the province of Catania, and about 34 miles S.W. of the city of that name, is situated on two rocky eminences united by a bridge, about 2170 feet above the level of the sea. It is well built and possesses a fine market-place, the ruins of a castle, a cathedral, several churches, and ten convents, a *casa communale* or town-house, built on ancient substructions, an orphanage, and a

total nu[illegible] Its inhabitants are said to have a much greater [illegible]d at 1[illegible] of culture than is common in the provincial towns knowi[illegible]ly, and great encouragement is given by the higher , but[illegible]s to the cause of education. The most remarkable [illegible]stry in the town is the manufacture of *terra-cotta* [illegible]es, representing different types of Italian costume. [illegible]e remains of an aqueduct, an ancient subterranean road [illegible]it out of the rock, and various mosaics and other [a]ntiquities discovered by excavation, show that the site of [t]he town was already occupied at a very early date; and [a]ccording to some an identification may be effected with [H]ybla Minor. The present city, however, owes its origin [t]o the Saracens, who defeated the Greeks there in 831, and [r]emained in possession till 1060.. Population, 25,978.

CALTANISETTA, or CALATANISETTA, the capital of a [p]rovince of the same name in Sicily, is situated in an [e]xtensive and fertile plain, dominated by Monte San [G]iuliano, near the right bank of the Salso, 62 miles S.E. [o]f Palermo. It is well built, and contains several handsome [e]difices, is defended by a castle, and is the seat of judicial [c]ourts. In the neighbourhood, at Terra-Pilata, are several [s]prings emitting hydrogen gas, a mud-volcano, and extensive [s]ulphur-works; and about 2 miles distant is the Abbey of [S]anto Spirito, founded by Roger I., where a great national [fe]stival is held every Whitmonday. The town is of [S]aracenic origin, as indeed its name suggests—Kalat-al-Nisa, [t]he Ladies' Castle; but it has been completely modernized. [I]n 1820 the people of Palermo were defeated near it by the [N]eapolitan General Pepe. Population, 26,156.

CALVADOS, a department in the north of France, [e]xtending from 48° 46′ to 49° 25′ N. lat., and from 0° 26′ [E]. to 1° 10′ W. long., formed out of that part of Lower [N]ormandy which comprised Bessin, Bocage, the Champagne [d]e Caen, Auge, and the western part of Lieuvin. It is [s]aid to have received its name from a ledge of rocks, [s]tretching along the coast for a distance of about 15 miles [b]etween the mouths of the rivers Orne and Vire, on [w]hich the *Calvados*, a vessel of the Spanish Armada, was [w]recked in 1588. It is bounded N. by the English [C]hannel, E. by the department of Eure, S. by that of [O]rne, W. by that of Manche, and has an area of 2132 [s]quare miles. The southern part of the department is [s]omewhat elevated, being crossed by a mountain range, and [f]orms a continuation of the great water-shed between the [b]asins of the Seine and Loire; but the rest of the surface [i]s gently undulating, and consists of extensive valleys [w]atered by numerous streams which fall into the English [C]hannel. The coast is high, and generally inaccessible, [e]xcept at the mouths of the principal rivers, such as the [T]ouques, the Dives, the Orne, and the Vire, which are [n]avigable at high tide for several miles inland, and are [i]ndicated by lighthouses at their mouths. The valleys, [w]hich generally slope in a direction from south to north, [a]fford abundant pasturage for horses and cattle, and the [a]griculture of the district is superior to that of most of the [o]ther departments. Wheat, potatoes, and all kinds of [v]egetables are raised in great quantities for the markets [o]f the interior and for exportation. The orchards of the [A]uge district produce a very superior kind of cider, of [w]hich upwards of 30,000,000 gallons are made in the [d]epartment; while Isigny is the centre of a large domestic [a]nd export trade in butter, cheese, and other dairy produce. [P]oultry is reared to a considerable extent for the Paris [m]arket. In the larger towns, of which on account of the [a]gricultural pursuits of the inhabitants there are very few, [t]here are manufactories of lace, woollen yarn and cloth, [l]inen, calicoes, flannel, shawls, cutlery, and earthenware. [B]esides these the paper-mills, oil-mills, tanneries, refineries [o]f beet-root and foreign sugar, distilleries, and bleach-fields, [s]cattered throughout the department, give employment to a great number of hands. Although seams of coal are found and wrought at Ligny, most of the coal used in the department is imported from England or Belgium. Building stone and fuller's earth are plentiful. The fisheries along the coast are extensively prosecuted for Parisian consumpt, and consist chiefly of lobster, oyster, herring, and mackerel fishing. There is a canal from Caen to Ouistreham. A line of railway from Paris to Cherbourg runs through the country and gives off five branches. The department is divided into six arrondissements,—Caen, Falaise, Bayeux, Vire, Lisieux, and Pont l'Evêque, the chief towns of which bear the same name. The principal port is Honfleur. The population in 1872 was 454,012.

CALVART, DENIS (1555-1619), a Flemish painter, born at Antwerp in 1555. After studying landscape-painting for some time in his native city he went to Bologna, where he perfected himself in the anatomy of the human form under Prospero Fontana, and so completely lost the mannerism of Flemish art that his paintings appear to be the work of an Italian. From Bologna he went to Rome, where he assisted Sabbatini in his works for the Papal palace, and devoted much of his time to copying and studying the works of Raffaelle. He ultimately returned to Bologna, and founded a school, of which the greatest ornaments are Guido and Domenichino. His works are especially admired for the power of grouping and colouring which they display. He died at Bologna in 1619

CALVERT, GEORGE, LORD BALTIMORE (1582-1632), one of the principal secretaries of state under James I., was born at Kipling in Yorkshire in 1582. He was educated at Oxford, and after travelling on the Continent entered public service as secretary to Robert Cecil, afterwards earl of Salisbury. In 1617 he was knighted, and in 1619 he was made one of the principal secretaries of state. He retained office for five years, at the end of which term he resigned, alleging as a reason that he had recently adopted the Catholic faith. He still continued at court, however, in the capacity of a privy-councillor. In 1625 he was made Baron Baltimore, in the county of Longford, Ireland, and among other rewards he received for his services was a patent as lord of the province of Avalon in Newfoundland. As this colony was much exposed to the attacks of the French he left it, and obtained another patent for Maryland, in the north of Virginia. He died in 1632 before the grant was confirmed, but in that year it was made out in the name of his son Cecil. The city of Baltimore derives its name from the title of this family.

CALVI, a fortified town in Corsica, the capital of an arrondissement, is situated on a peninsula in the bay to which it gives its name, 38 miles W.S.W. of Bastia, in 42° 34′ 7″ N. lat. and 8° 45′ 10″ E. long. Its position is unsheltered, and its ancient fortifications present a mournful appearance, while its climate is rendered unhealthy by the exhalations from the neighbouring lagoon. Since the foundation of Ile Rousse by Paoli it has greatly decayed, and its interest is now mainly historical or antiquarian. The most important buildings are the old palace of the Genoese governor and the church with the monuments of the Baglioni family. Calvi was founded in the 13th century by Giovanniello of Pietra Allerata, one of the military adventurers of that restless period. In 1278 it passed into the hands of the Genoese, and from that date it was remarkable for its adherence to their side. It was attacked by De Thermes in 1553, and two years after it stood no fewer than three sieges with such determined resistance that the Genoese senate caused *Civitas Calvi semper fidelis* to be carved on the chief gate of the city, which still preserves the proud inscription. In 1794 Calvi was captured by the English, but it was retaken by the Corsicans in the following year. Population in 1872, 2164.

CALVIN, John (1509–1564), was born at Noyon, in Picardy, July 10, 1509. His father, Gerard Calvin or Cauvin,[1] was a notary-apostolic and procurator-fiscal for the lordship of Noyon, besides holding certain ecclesiastical offices in connection with that diocese. The name of his mother was Jeanne Lefranc; she was the daughter of an innkeeper at Cambray, who afterwards came to reside at Noyon. Gerard Calvin is described as a man of considerable sagacity and prudence, and on this account held in esteem by the leading men of the district. His wife added to considerable personal attractions the graces of a vivid and earnest piety. Their family consisted of four sons, of whom John was the second, and two daughters.

Of Calvin's early years only a few notices remain. His father destined him from the first for theological studies, being moved to this by the evidences afforded in his boyhood of a religious tendency, and perhaps also by a shrewd apprehension of the kind of pursuits in which he was most fitted to excel. The esteem in which the father was held opened for the boy a place in the household of the noble family of De Montmor, where he received his elementary education along with the children of the house, though at his father's expense. In his thirteenth year his father, whose circumstances were not affluent, procured for him from the bishop the office of chaplain in the Chapelle de Nôtre Dame de la Gesine. A few days after his appointment he received the tonsure, and on the 29th of May 1521 he was installed in his office. The plague having visited Noyon, the young De Montmors were sent to Paris to pursue their studies there, and thither Calvin accompanied them, being enabled by the income received from his benefice to meet the expense of a residence in the metropolis. His first school was the Collége de la Marche, at that time under the regency of Maturin Cordier, a man of excellent character, of sound learning, and of high repute as a teacher. To him Calvin ever acknowledged himself indebted for the benefits received under his tuition. In dedicating to him his Commentary on the First Epistle to the Thessalonians, as "eximiæ pietatis et doctrinæ viro," he declares that so had he been aided by his instruction that whatever subsequent progress he had made he only regarded as received from him, and "this," he adds, "I wish to testify to posterity that if any utility accrue to any from my writings they may acknowledge it as having in part flowed from thee." From this institution he removed to the Collége Montaigu, where he had for instructor a Spaniard, who is described as a man of learning, and to whom Calvin was indebted for the culture of his already acute intellect, by the study of dialectics and the scholastic philosophy. Whilst at school the future reformer distinguished himself by his superior abilities, and his indefatigable assiduity. He speedily outstripped all his competitors in grammatical studies, and by his skill and acumen as a student of philosophy, gave fruitful promise of that consummate excellence as a reasoner, in the department of speculative truth, which he afterwards displayed. Intensely devoted to study he cared little for the pastimes in which his fellow scholars indulged; he shunned society, and was more disposed to censure the frivolities of those around him than to seek the solace of their companionship; severe to others he was still more so to himself, and his pale face and attenuated frame bore witness at once to the rigour of his abstinence and the ardour with which he prosecuted his studies. In his nineteenth year he, through the influence of his father, obtained the living of Marteville, to which he was presented on the 27th of September 1527. After holding this preferment for nearly two years, he exchanged it in July 1529 for the cure of Pont l'Evêque, a village near to Noyon, and the place to which his father originally belonged. He appears to have been not a little elated by his early promotion, and although not ordained, he preached several sermons to the people. But though the career of ecclesiastical preferment was thus early opened to him, Calvin was destined not to become a priest of the Church of Rome. A change came over the mind both of his father and himself respecting his future career. Gerard Calvin, looking at things only from a worldly point of view, began to suspect that he had not chosen the most lucrative profession for his son, and that the law offered to a youth of his talents and industry a more promising sphere.[2] His son, on the other hand, had come under an influence of a very different kind, but which, with still more decisive impulse, inclined him to relinquish the ecclesiastical life. Through the counsels of his relation, Pierre Robert Olivetan, the first translator of the Bible into French, he had been led for the first time to study the sacred volume, and to test his religious opinions and practices by its dictates. The result was that, though not yet detached from the faith of the Romish church, he was very willing to relinquish all thoughts of becoming a priest in that communion. He accordingly readily complied with his father's suggestion; and having resigned his cure, he removed from Paris to Orleans, in order to study law under Pierre de l'Etoile, a distinguished jurisconsult, and at that time professor there. On this new pursuit Calvin entered with characteristic ardour, and such was his progress in legal knowledge, that he frequently occupied the chair of the professor, while his general reputation for ability and scholarship stood so high that, on leaving Orleans, he received the grade of doctor without payment of the usual fees, as a compliment to his merits. Other studies, however, besides those of law had occupied him whilst in this city. God, who had destined him for a very different career, was in His providence preparing him for the work he had to do. His mind, at first hardened by the influence of early superstition, was, he himself tells us, brought by sudden conversion into a state of docility.[3] An ardent desire to attain proficiency in sacred knowledge took possession of him, and though this did not lead him to renounce other studies, it rendered him frigid in the pursuit of them. At all times, indeed, a diligent student, he seems at this time to have been impelled by his zeal beyond those bounds which a wise regard to health would impose. It was his wont, after a frugal supper, to labour till midnight, and in the morning when he awoke, he would, before he arose, recall and digest what he had read the previous day, so as to make it thoroughly his own. "By these protracted vigils," says Beza, "he secured indeed a solid erudition, and an excellent memory; but it is probable he at the same time sowed the seeds of that disease which occasioned him various illnesses in after life, and at last brought upon him premature death."[4]

From Orleans Calvin went to Bourges to prosecute his studies under a learned Italian of the name of Alciati, whom Francis I. had invited into France, and settled as a professor of law in that university. Here he became acquainted with Melchior Volmar, a German, then professor of Greek at Bourges, and a man of sound erudition

[1] The family name of Calvin seems to have been written indifferently Cauvin, Chauve, Chauvin, Calvus, Calvinus. In the contemporary notices of Gerard and his family, in the capitular registers of the cathedral at Noyon, the name is always spelt Cauuin. The anagram of Calvin is Alcuin, and this in its Latinized form Alcuinus appears in two editions of his *Institutio* as that of the author (Audin, *Vie de Calvin*, i. 520). The syndics of Geneva address him in a letter written in 1540, and still preserved, as "Docteur Caulvin." In his letters written in French he usually signs himself "Jean Calvin." He affected the title of "Maitre," for what reason is not known.

[2] Calv., *Præf. ad Comment. in Psalmos.*

[3] *Præf. ad Psalmos.*

[4] *Jo. Calvini Vita, sub init.*

as well as exemplary character. By him Calvin was taught Greek, and introduced to the study of the New Testament in its original language, a service which he gratefully acknowledges in one of his printed works.[1] The conversation of Volmar also seems to have been of use to him in deepening his religious convictions, and confirming him in his attachment to the doctrines of the Reformation. These were now beginning to be widely diffused through France. Twelve years had elapsed since Luther had published his theses against indulgences,—twelve years of intense excitement and anxious discussion, not in Germany only, but in almost all the adjacent kingdoms In France there had not been as yet any overt revolt against the Church of Rome, but multitudes were lending a friendly ear to the Reformed doctrines, and a few were in secret rejoicing in having heartily embraced them To such Calvin united himself whilst at Orleans, and after his removal to Bourges he became a teacher, both in private conference with inquirers and by discourses in more public assemblies. "Before a year had elapsed," says he, speaking of his conversion,—"all who were desirous of a purer doctrine were in the habit of coming to me, though a novice and a tyro, for the purpose of learning."[2] And Beza tells us that he not only fortified the few believers who were in the town, but preached often in some of the neighbouring mansions and hamlets, whereby he wonderfully advanced the kingdom of God in many families, among which he specifies that of the lord of Ligniéres, who with his lady heard with approval the new doctrines.[3] In engaging in such efforts, Calvin appears to have yielded to a constraining sense of duty rather than to have followed the bias of his own inclinations. "By nature," says he, "somewhat clownish (*subrusticus*), I always preferred the shade and ease, and would have sought some hiding-place ; but this was not permitted, for all my retreats became like public schools."[4] Nor did he infuse any of the enthusiasm which usually marks the young reformer into his addresses. "He taught the truth," says Beza, "not with affected eloquence, but with such depth of knowledge and so much solid gravity of style, that there was not a man who could hear him without being ravished with admiration."[5]

His residence at Bourges was cut short by the sudden death of his father, which occasioned his return to his native place. Immediately after his father's decease, he seems to have paid a hasty visit to Paris, and then to have returned to Noyon, where he resided for a couple of years or so. At the close of this period he appears to have returned to Paris, where he apparently resided from 1529 to 1532, as letters written by him are dated from Paris in these years. While there he lodged with a tradesman, Etienne de la Forge, who early fell a victim to his zeal for the Reformation, and "whose memory," Calvin says, "should be blessed among believers as a holy martyr for Christ."[6] In his house the friends of evangelical truth were wont to meet, and Calvin not only associated with them, but frequently preached in their assemblies. To the great joy of all such, he at length entirely relinquished his legal pursuits and devoted himself afresh to theology, —giving himself up wholly to the work, preaching with great energy, and using all the means in his power to win converts to the truth, as well as to confirm those by whom it had been already embraced. By this time the Reformation had attracted so many adherents in France, that the upholders of the established system became infuriated, and attempted to stay its further progress by the most cruel persecutions. It was whilst these were raging that Calvin issued his first publication, an edition of Seneca's tract *De Clementia*, with an elaborate commentary. This book he published at his own cost, and dedicated to Claude Hangest, abbot of St Eloi, a member of the De Montmor family, with whom Calvin had been brought up. The commentary, which is written in that pure and terse Latinity which characterizes all Calvin's works composed in the language of ancient Rome, displays extensive acquaintance with ancient literature, though the author has fallen into the extraordinary mistake of running the two Senecas, father and son, into one, and making the philosopher die 115 years old. It has been suggested that Calvin published this work with a view to influence the king to put a stop to the persecution of the Protestants, but there is nothing in the treatise itself or in the commentary to favour this opinion.

This work was published in April 1532, and seems to have brought Calvin more of honour than of profit. It appears, indeed, that he had some difficulty in paying the cost of its publication; and it is probable that it was partly in order to meet this that he sold at this time the slender patrimony which his father had left him. He at this time also relinquished the ecclesiastical preferments which he had hitherto continued to hold, an act which, though demanded by the change that had taken place in his religious views, was entirely voluntary on his part, and, when viewed in connection with his then straitened circumstances, must be put to the credit of his integrity and disinterestedness. He was now in his twenty-fourth year, and was already recognized as at the head of the Reformation movement in France. An occasion soon occurred which brought him into open collision with the dominant party. Nicholas Cop, the newly-elected regent of the Sorbonne, had to deliver an oration according to custom in the Church of the Maturins, on the feast of All Saints. Being intimate with Calvin, he pronounced an oration which the latter had prepared for him, "of a totally different sort," says Beza, "from what was customary."[7] It was, in fact, a defence of the Reformed opinions, especially of the doctrine of justification by faith alone. This was more than the Sorbonnists could bear, and Cop, being summoned to appear before the parliament, found it necessary to make his escape from Paris to Basel. An attempt was at the same time made to seize Calvin, but being forewarned of the design by his friends, he also made his escape. His lodgings, however, were searched, and his books and papers seized, to the imminent peril of some of his friends, whose letters were found in his repositories. He himself retired first to the castle of Lord de Hazeville near Mantes, and after that to Saintonge, where he was the guest of Louis du Tillet, a canon of Angoulême, and where at the request of his host he prepared some short discourses, which were circulated in the surrounding parishes, and read in public to the people. He subsequently removed to Nerac, the residence of the queen of Navarre, the only sister of Francis I., who then favoured the Reformers, and through whose intercession the storm that had broken out against them was for the time abated. Here he became acquainted with the venerable Jacques Lefevre d' Estaples, a scholar and man of science, whom the queen had rescued from the fury of the Sorbonnists, and engaged as tutor to her children. By him Calvin was warmly received, and his future eminence as a reformer of the church predicted.

It has been asserted that it was whilst resident at Saintonge that Calvin prepared the first sketch of his *Institutio Christianæ Religionis*; but this has not been proved. His residence in that retirement continued only

[1] *Epist. Ded., Comment. in Ep. II. ad Corinthios præfix.*
[2] *Præf. ad Psalmos.*
[3] *Hist. Eccles.*, t. i. pp. 6, 7 ; Lille, 1841. [4] *Præf. ad Psalmos.*
[5] *Hist. Eccles. ubi. sup.* [6] Calv., *Contr. Libertinos*, c. 4.
[7] *Hist. Eccles.*, vol. i. p. 9.

for a very few months; for, in 1534, we find him first at Noyon, his native place, and soon after again in Paris. Here he was compelled to remain concealed, in consequence of the measures which the enemies of the Reformation were still pursuing against its adherents. At the risk of his life, however, he came forth to meet one whom he was afterwards to encounter under very different circumstances, the Spanish physician, Servede or Servetus, who was even then engaged in propagating his heretical notions concerning the Trinity. Servetus having expressed a desire to have a conference with Calvin, it was arranged that they should meet and discuss their conflicting opinions; but though Calvin waited for him long at the time and place appointed, Servetus failed to make his appearance, "being," says Beza, "unable to endure the sight of Calvin," but more probably deterred by the danger to which both were exposed from the hostility of the ruling powers. Calvin's design in acceding to this colloquy seems to have been a kindly one towards Servetus. "Not without danger to my life," he himself says, "I offered to deliver him from his errors."[1] Nor was Servetus the only errorist whom Calvin endeavoured at this time to confute. The Anabaptists of Germany had spread into France, and were disseminating many wild and fanatical opinions among those who had seceded from the Church of Rome. Among other notions which they had imbibed, was that of a sleep of the soul after death. To Calvin this notion appeared so pernicious, that he composed and published a treatise in refutation of it, under the title of *Psychopannychia.* In this work he chiefly dwells upon the evidence from Scripture in favour of the belief that the soul retains its intelligent consciousness after its separation from the body,—passing by questions of philosophical speculation, as tending on such a subject only to minister to an idle curiosity.

The *Psychopannychia* was published in 1534 at Orleans, whither Calvin had been constrained, in consequence of the violence of the persecution at Paris, to retreat. On his way thither he stopped for some time at Poitiers. Here many gathered round him desirous of instruction from him; and in a grotto near the town he celebrated for the first time the communion in the Evangelical Church of France, using a piece of the rock as a table. From this time forward his influence became supreme, and all who had imbibed or become tinged with the Reformed doctrines in France turned to him for counsel and instruction, attracted not only by his power as a teacher, but still more, perhaps, because they saw in him so full a development of the Christian life according to the evangelical model. M. Renan, no prejudiced judge, pronounces him "the most Christian man of his time," and attributes to this his success as a reformer. Certain it is that already he had drawn upon him the notice of those who were seeking to extinguish in blood the light which had been kindled, and which he was so prompt to hold up to view; so that he was obliged to seek safety in flight. In company with his friend Louis du Tillet, whom he had again gone to Angoulême to visit, he set out for Basel. On their way they were robbed by one of their servants, who so entirely stripped them of their property, that it was only by borrowing ten crowns from their other servant that they were enabled to get to Strasburg, and thence to Basel. Here Calvin was welcomed by the band of scholars and theologians who had conspired to make that city the Athens of Switzerland, and especially by the learned Simon Grynæus, and by Wolfgang Capito, the leader of the Reformation at Basel. Under the auspices and guidance of the latter, Calvin applied himself to the study of Hebrew.

Francis I., desirous to continue the persecution of the Protestants, but anxious at the same time not to break with the Protestant princes of Germany, resorted to the unworthy expedient of instructing his ambassador to assure the latter that it was only against the Anabaptists, and other parties who called in question all civil magistracy, that his severities were exercised. Calvin, indignant at the calumny which was thus cast upon the Reformed party in France, hastily prepared for the press his *Institutes of the Christian Religion*, which he published as a confession of the Reformed faith, and dedicated to the king. This work Calvin says he wrote in Latin that it might find access to the learned in all lands.[2] Soon after it appeared he set about translating it into French, as he himself attests in a letter dated October 1536. This sets at rest a question, at one time much agitated, whether the book appeared first in French or in Latin. The earliest French edition known is that of 1540, and this was after the work had been much enlarged, and several Latin editions had appeared. In its first form the work consisted of only six chapters, and was intended merely as a brief manual of Christian doctrine. It appeared anonymously, the author having, as he himself says, nothing in view beyond furnishing a statement of the faith of the persecuted Protestants, whom he saw cruelly cut to pieces by impious and perfidious court parasites.[3] In this work, though produced when the author was only twenty-five years of age, we find a complete outline of that theological system which has since borne his name. In none of the later editions, nor in any of his later works, do we find reason to believe that he ever changed his views on any essential point from what they were at the period of its first publication. Such an instance of maturity of mind and of opinion at so early an age, would be remarkable under any circumstances; but in Calvin's case it is rendered peculiarly so, by the shortness of the time which had elapsed since he gave himself to theological studies. It may be doubted also if the history of literature presents us with another instance of a book written at so early an age, which has exercised such a prodigious influence upon the opinions and practices both of contemporaries and of posterity.

After a short visit to the court of the duchess of Ferrara, which at that time afforded an asylum to several learned and pious fugitives from persecution, Calvin returned to France to arrange his affairs before finally taking farewell of his native country. His intention was to settle at Basel, and to devote himself to study. But being unable, in consequence of the disturbed state of the country, to reach Basel by the ordinary route, he had to take the route through Geneva. Whilst in this city his further progress was arrested, and his resolution to pursue the quiet path of studious research was dispelled, by what he calls the "formidable obtestation" of Farel.[4] After many struggles and no small suffering, this energetic spirit had succeeded in planting the evangelical standard at Geneva; and anxious to secure the aid of such a man as Calvin, he entreated him on his arrival to relinquish his design of going farther, and to devote himself to the work in that city. Calvin at first declined, alleging as an excuse his need of securing more time for personal improvement, which could not be obtained were he engaged in ministerial work. To the ardent Farel this seemed a mere pretext for indolence. "I tell you," he continued, "in answer to this pretence of your studies, in the name of Almighty God, that if you will not devote yourself with us to this work of the Lord, the Lord will curse you as one seeking not Christ so much as himself." Startled by this denunciation, and feeling as if God had laid his hand on him to detain him, Calvin consented to remain at Geneva, where

[1] *Calvini Refut. Errorum Serveti, Opp.*, t. viii. p.511.; Ed. Amstel.

[2] This edition forms a small 8vo of 514 pages, and 6 pages of index. It appeared at Basel from the press of Thomas Platter and Balthasar Lasius in March 1536.

[3] *Præf. ad Psalmos.*

[4] *Ibid.*

he was immediately appointed teacher of theology. He was also elected preacher by the magistrates with the consent of the people, but this office he would not accept until it had been repeatedly pressed upon him. His services seem to have been rendered for some time gratuitously, for in February 1537, there is an entry in the city registers to the effect that six crowns had been voted to him, "since he has as yet hardly received anything."

Calvin was in his twenty-eighth year when he was thus constrained to settle at Geneva; and in this city the rest of his life, with the exception of a brief interval, was spent. The post to which he was thus called was not an easy one. Though the people of Geneva had cast off the yoke of Rome, they were still "but very imperfectly enlightened in divine knowledge; they had as yet hardly emerged from the filth of the papacy."[1] This laid them open to the incursions of those fanatical teachers, whom the excitement attendant upon the Reformation had called forth, and who hung mischievously upon the rear of the reforming body. To obviate the evils thence resulting, Calvin, in union with Farel, drew up a condensed statement of Christian doctrine consisting of twenty-one articles. This the citizens were summoned, in parties of ten each, to profess and swear to as the confession of their faith—a process which, though not in accordance with modern notions of the best way of establishing men in the faith, was gone through, Calvin tells us, "with much satisfaction." As the people took this oath in the capacity of *citizens*, we may see here the basis laid for that theocratic system which subsequently became peculiarly characteristic of the Genevan polity. Deeply convinced of the importance of education for the young, Calvin and his coadjutors were solicitous to establish schools throughout the canton, and to enforce on parents the sending of their children to them; and as he had no faith in education apart from religious training, he drew up an elementary catechism of Christian doctrine which the children had to learn whilst they were receiving secular instruction. Of the troubles which arose from fanatical teachers, the chief proceeded from the efforts of the Anabaptists; but these Calvin and his colleagues so effectually silenced by means of a public disputation held on the 18th of March 1537, that they never afterwards appeared at Geneva. In the course of this year also, the peace of Calvin and his friends was much disturbed, and their work interrupted, by a turbulent and unprincipled preacher named Peter Caroli, who, after many changes of religious profession (with none of which, however, had he associated anything of true religion, or even much of ordinary morality), had assumed the character of a stickler for orthodoxy. In this character he accused the Geneva divines of Sabellianism and Arianism, because they would not enforce the Athanasian creed, and had not used the words "Trinity" and "Person" in the confession they had drawn up. In a synod held at Bern the matter was fully discussed, when a verdict was given in favour of the Geneva divines, and Caroli deposed from his office and banished. Thus ended an affair which seems to have occasioned Calvin much more uneasiness than the character of his assailant, and the manifest falsehood of the charge brought against him, would seem to justify. Two brief tracts, intended to expose the evils and warn against the seductions of Popery, one entitled *De Fugienda Idolatria*, the other *De Papisticis Sacerdotiis*, must be added to the labours of Calvin this year.

Hardly was the affair of Caroli settled, when new and severer trials came upon the Genevan Reformers. The severe simplicity of the ritual which Farel had introduced, and to which Calvin had conformed; the strictness with which the ministers sought to enforce not only the laws of morality, but certain sumptuary regulations respecting the dress and mode of living of the citizens; and their determination in spiritual matters not to submit to the least dictation from the civil power, led to such violent dissensions that Calvin and his colleagues refused to administer the sacrament to the people. For this they were banished from the city. They went first to Bern, and soon after to Zurich, where a synod of the Swiss pastors had been convened. Before this assembly they pleaded their cause, and stated what were the points on which they were prepared to insist as needful for the proper discipline of the church. They declared that they would yield in the matter of ceremonies so far as to employ unleavened bread in the eucharist, to use fonts in baptism, and to allow festival days, provided the people might pursue their ordinary avocations after public service. These Calvin regarded as matters of indifference, provided the magistrates did not make them of importance, by seeking to enforce them; and he was the more willing to concede them, because he hoped thereby to meet the wishes of the Bernese brethren, whose ritual was less simple than that established by Farel at Geneva. But he and his colleagues insisted, on the other hand, that for the proper maintenance of discipline, there should be a division of parishes—that excommunications should be permitted, and should be under the power of elders chosen by the council, in conjunction with the clergy—that order should be observed in the admission of preachers—and that only the clergy should officiate in ordination by the laying on of hands. It was proposed also, as conducive to the welfare of the church, that the sacrament of the Lord's Supper should be administered more frequently, at least once every month, and that congregational singing of psalms should be practised in the churches. On these terms the synod interceded with the Genevese to restore their pastors; but through the opposition of the Bernese this was frustrated, and a second edict of banishment was the only response.

Calvin and Farel betook themselves, under these circumstances, to Basel, where they soon after separated, Farel to go to Neufchatel, and Calvin to Strasburg. At the latter place Calvin resided till the autumn of 1541, occupying himself partly in literary exertions, partly as a preacher in the French church, and partly as a lecturer on theology. In 1539 he attended the convention at Frankfort as the companion of Bucer, and in the following year he appeared at that at Hagenau and Worms, as the delegate from the city of Strasburg. He was present also at the diet at Ratisbon, where he became personally acquainted with Melanchthon, and formed with him a friendship which lasted through life. It is to this period of his life that we owe the completed form of his *Institutio*, his Commentary on the Epistle to the Romans, and his Tract on the Lord's Supper. Notwithstanding his manifold engagements, he found time to attend to the tenderer affections; for it was during his residence at Strasburg that he married Idelette de Bures or van Buren, the widow of a person named Störder, whom he had converted from Anabaptism. In her Calvin found, to use his own words, "the excellent companion of his life," a "precious help" to him amid his manifold labours and frequent infirmities. She died, in 1549, to the great grief of her husband, who never ceased to mourn her loss.

During his absence, disorder and irreligion had prevailed in Geneva. An attempt was made by Sadolet, bishop of Carpentras, to take advantage of this so as to restore the papal supremacy in that district; but this design Calvin, watchful over the interests of his ungrateful flock, though exiled from them, completely frustrated by writing such a reply to the letter which the bishop had addressed to the

[1] Beza, *Vit. Calv. an.* 1536.

Genevese, as constrained him to desist from all further efforts. He seems also to have kept up his connection with Geneva by addressing letters of counsel and comfort to the faithful there who continued to regard him with affection. It was whilst he was still at Strasburg that there appeared at Geneva a translation of the Bible into French, bearing Calvin's name, but in reality only revised and corrected by him from the version of Olivetan. Meanwhile the way had been opened for his return to the post whence he had been driven in that city. In the summer of 1541, the decree of his banishment was revoked, and in the following September he yielded to the earnest entreaties of his now penitent flock, and returned to Geneva, where he was received with the utmost enthusiasm. He entered upon his work with a firm determination to carry out those reforms which he had originally purposed, and to set up in all its integrity that form of church policy which he had carefully matured during his residence at Strasburg. He now became the sole directive spirit in the church at Geneva. Farel was retained by the Neufchatelois, and Viret, soon after Calvin's return, removed to Lausanne. His duties were thus rendered exceedingly onerous, and his labour became excessive. Besides preaching every day in each alternate week, he taught theology three days in the week, attended weekly meetings of his consistory, read the Scriptures once a week in the congregation, carried on an extensive correspondence on a multiplicity of subjects, prepared commentaries on the books of Scripture, and was engaged repeatedly in controversy with the opponents of his opinions. "I have not time," he writes to a friend, "to look out of my house at the blessed sun, and if things continue thus, I shall forget what sort of appearance it has. When I have settled my usual business, I have so many letters to write, so many questions to answer, that many a night is spent without any offering of sleep being brought to nature." We cannot in this sketch follow him through all the details of his brief but busy life after he returned to Geneva; we can only afford to notice slightly the leading events.

Of the controversies in which Calvin embarked, one of the most important was that in which he defended his doctrine concerning predestination and election. His first antagonist on this head was Pighius, a Romanist, who, resuming the controversy between Erasmus and Luther on the freedom of the will, violently attacked Calvin for the views he had expressed on that subject. Calvin replied to him in a work published in 1543, in which he defends his own opinions at length, as well by general reasonings as by an appeal to both Scripture and the Fathers, especially Augustine. So potent were his reasonings in the esteem of his opponent, that the latter, though owing nothing to the gentleness or courtesy of Calvin, was led to embrace his views. A still more vexatious and protracted controversy on the same subject arose in 1551, in which Calvin was called to defend his views against Bolsec, originally a Carmelite friar, but who having renounced Romanism had fled from France and come to Geneva, where he appeared as a physician. In becoming a physician, however, he had not relinquished theological studies, and being a zealous opponent of predestinarian views, he was tempted on one occasion, after a sermon on the subject by Calvin to attack him in the public assembly. Calvin replied with equal vehemence; and an officer of police, scandalized that such a scene should occur in church, took Bolsec into custody. The pastors resolved to have a conference with him before the council; and for two days the discussion was conducted by him and Calvin with much ability on both sides. The council were at a loss what course to take; not that they doubted which of the disputants was right, for they all held by the views of Calvin, but they were unable to determine to what extent and in which way Bolsec should be punished for his heresy. The question was submitted to the Swiss churches, but they also were divided in their judgment, some counselling severity, others gentle measures. The result was that Bolsec was banished from Geneva. The enemies of Calvin insinuated that he counselled the infliction of a heavier penalty; but this he himself in a letter to Bullinger indignantly denies. In this controversy ultimately several others, including Castellio, Fabri, and even Bullinger and Melanchthon took part against Calvin, and only Beza appeared as a zealous coadjutor. But the most memorable of all the controversies in which Calvin was engaged, was that into which he was brought in 1553 with his old antagonist Servetus. After many wanderings, and after having been condemned to death for heresy at Vienne, from which he was fortunate enough to make his escape, Servetus arrived in July 1553 at Geneva. He appears to have remained in quiet here for some time, and was about to leave for Zurich when, at the instigation of Calvin, he was arrested and conveyed to prison on the charge of blasphemy. This charge was founded on certain statements in a book published by him in 1553, entitled *Christianismi Restitutio*, in which he animadverted in terms needlessly offensive on the Catholic doctrine of the Trinity, and advanced sentiments strongly savouring of Pantheism.[1] At the trial which followed Calvin appeared as his accuser, and the conflict was conducted between the two with much ability on both sides, and at the same time with no small keenness and bitterness. After a protracted trial, the accused was condemned to be burnt to death, and was accordingly burned at Champel near Geneva, on the 27th of October 1553. Farel attended him in his last hours, and accompanied him to the place of execution. He had an interview also with Calvin on the morning of the fatal day, when he asked his forgiveness, but refused to retract any of his expressions. Calvin has been much censured, not to say vituperated, for his share in this unhappy transaction. In order to aggravate the charge against him it has been alleged that it was by his invitation that Servetus came to Geneva, that it was by his urgency that the magistrates, over whom his influence was unbounded, condemned Servetus to death, and that it was to gratify a personal pique and through hatred of Servetus that he thus cruelly and relentlessly pursued him. Of these allegations not one can be proved, and some are undoubtedly false. It is not true that Calvin induced Servetus to come to Geneva; on the contrary, when Servetus intimated a wish to visit that city if it pleased Calvin that he should do so, Calvin intimated very plainly that it did not please him, and refused to pledge himself for his safety should he come, as he was resolved, should he come, to prosecute him to the death.[2] That Calvin influenced the magistrates to condemn Servetus is true only in the same sense in which any public prosecutor who pleads before the judge for the condemnation of one against whom he brings a criminal charge, may be said to influence the judge to condemn him. As for the assertion that Calvin's influence with the magistrates was unbounded, this falls to the ground before the fact that at this time he was in a state of antagonism with the dominant party.[3] That Calvin hated the doctrines which he found in Servetus's book there can be no doubt, and that he thought the author of such views as were there advanced

[1] A digest of Servetus's views is given by Dorner, *Entwickelungsgeschichte der Lehre von d. Person Christi*, ii. pp. 649–656, Eng. trans. div. ii., vol. ii. pp. 161–168.

[2] Si mihi placeat huc se venturum recipit. Sed nolo fidem meam interponere. Nam si modo valeat mea autoritas vivum exire nunquam patiar.—Calvin to Farel, 12th Feb. 1546.

[3] See art. "Servet" by Trechsel in Herzog's *Real-Encyclopädie*, v. xiv. p. 297.

deserving of death, if he refused when reasoned with to recant, is unhappily true; but that he was actuated by personal spite and animosity against Servetus himself there is no evidence; on the contrary we have his own express declaration that, after Servetus was convicted, he used no urgency that he should be put to death, and at their last interview he told Servetus that he never had avenged private injuries, and assured him that if he would repent it would not be his fault if all the pious did not give him their hands.[1] There is the fact also that Calvin used his endeavour to have the sentence which had been pronounced against Servetus mitigated, death by burning being regarded by him as an "atrocity," for which he sought to substitute death by the sword.[2] All that can be justly charged against Calvin in this matter is that he took the initiative in bringing on the trial of Servetus, that as his accuser he prosecuted the suit against him with undue severity, and that he approved the sentence which condemned Servetus to death. When, however, it is remembered that the unanimous decision of the Swiss churches and of the Swiss state Governments was that Servetus deserved to die; that the general voice of Christendom was in favour of this; that even such a man as Melanchthon affirmed the justice of the sentence;[3] that an eminent English divine of the next age should declare the process against him "just and honourable,"[4] and that only a few voices here and there were at the time raised against it, candid and impartial men will be ready to accept the judgment of Coleridge, that the death of Servetus was not "Calvin's guilt especially, but the common opprobrium of all European Christendom."[5]

The heresy of Servetus was not extirpated by his death, but none of his followers were visited with severer penalties than that of banishment from Geneva. The trials of several of these, with the conferences and controversies connected with them, occupied much of Calvin's time for several years. He was also involved in a protracted and somewhat vexing dispute with the Lutherans respecting the Lord's Supper, which ended in the separation of the evangelical party into the two great sections of Lutherans and Reformed,—the former of whom hold that in the eucharist the body and blood of Christ are objectively and consubstantially present, and so are actually partaken of by the communicants, whilst the latter maintain that there is only a virtual presence of the body and blood of Christ, and consequently only a spiritual participation thereof through faith. In connection with these controversies on points of faith, Calvin was for many years greatly disquieted, and sometimes even endangered, by the opposition offered by the libertine party in Geneva to the ecclesiastical discipline which he had established there. His system of church polity was essentially theocratic; it assumed that every member of the state was also under the discipline of the church; and he asserted that the right of exercising this discipline was vested exclusively in the consistory or body of preachers and elders. His attempts to carry out these views brought him into collision both with the authorities and with the populace,—the latter being enraged at the restraints imposed upon the disorderly by the exercise of church discipline, and the former being inclined to retain in their own hands a portion of that power in things spiritual which Calvin was bent on placing exclusively in the hands of the church rulers. His dauntless courage, his perseverance, and his earnestness at length prevailed, and he had the satisfaction, before he died, of seeing his favourite system of church polity firmly established, not only at Geneva, but in other parts of Switzerland, and of knowing that it had been adopted substantially by the Reformers in France and Scotland. Nor was it only in religious matters that Calvin busied himself; nothing was indifferent to him that concerned the welfare and good order of the state or the advantage of its citizens. His work, as has been justly said, "embraced everything;" he was consulted on every affair, great and small, that came before the council,—on questions of law, police, economy, trade, and manufactures, no less than on questions of doctrine and church polity. To him Geneva owed her trade in cloths and velvets, from which so much wealth accrued to her citizens; sanitary regulations were introduced by him which made Geneva the admiration of all visitors; and in him she reverences the founder of her college, which still flourishes, and from which so many learned men have gone forth.

Amidst these multitudinous cares and occupations, Calvin found time to commit to writing a number of works besides those provoked by the various controversies in which he was engaged. The most numerous of these were of an exegetical character. Including discourses taken down from his lips by faithful auditors, we have from him expository comments or homilies on nearly all the books of Scripture, written partly in Latin and partly in French. In the estimation of many, these constitute the most valuable of his works. His candour and sincerity as an inquirer into the meaning of Scripture—his judiciousness, penetration, and tact in eliciting his author's meaning—his precision, condensation, and concinnity as an expositor—the accuracy of his learning, the closeness of his reasoning, and the elegance of his style, all conspire to confer a high value on his exegetical works, and to make them at once rich sources of biblical knowledge and admirable models of biblical exposition.

But it is chiefly as a theologian and the head of a theological school that Calvin is now known. This renders it fitting that some account should be here given of his theological system. This is developed in his *Institutio*, which, though produced originally at an early period of his life, was so frequently and carefully revised by him, that in the form in which it has come down to us it presents his most matured views and thoughts. In some of his tracts and polemical writings certain of his doctrines are more fully expounded, illustrated, and defended; but nowhere has he advocated any tenet which is not in substance to be found in the *Institutio*.

Much of Calvin's theology is common to him with all evangelical divines, and in the parts which are more peculiar to him and his school he follows closely in the steps of Augustine. The following may be regarded as his characteristic tenets, though all are not peculiar to him.

Man as a sinner is guilty and corrupt. The first man was made in the image and likeness of God, which not only implies man's superiority to all other creatures, but indicates his original purity, integrity, and sanctity. From this state Adam fell, and in his fall involved the whole human race descended from him. Hence depravity and corruption, diffused through all parts of the soul, attach to all men, and this first makes them obnoxious to the anger of God, and then comes forth in works which the Scripture calls works of the flesh (Gal. v. 19). Thus all are held vitiated and perverted in all parts of their nature, and on account of such corruption deservedly condemned before God, by whom nothing is accepted save righteousness, innocence, and purity. Nor is that a being bound for another's offence; for when it is

[1] Fidelis Expositio Errorum Serveti, *sub init.* Calvini *Opp.* t. ix.
[2] Calvin to Farel, 20th Aug. 1553.
[3] Tuo judicio prorsus assentior. Affirmo etiam vestros magistratus juste fecisse quod hominem blasphemum, re ordine judicata, interfecerunt.—Melanchthon to Calvin, 14th Oct. 1554.
[4] Field *On the Church*, bk. iii. c. 27, vol. i. p. 288, ed. Camb. 1847.
[5] *Notes on English Divines*, vol. i. p. 49. See also *Table Talk*, vol. ii. p. 252, ed. 1835

said that we through Adam's sin have become obnoxious to the divine judgment, it is not to be taken as if we, being ourselves innocent and blameless, bear the fault of his offence, but that, we having been brought under a curse through his transgression, he is said to have bound us. From him, however, not only has punishment overtaken us, but a pestilence instilled from him resides in us, to which punishment is justly due. Thus even infants, whilst they bring their own condemnation with them from their mother's womb, are bound not by another's but by their own fault. For though they have not yet brought forth the fruits of their iniquity, they have the seed shut up in them; nay, their whole nature is a sort of seed of sin, therefore it cannot but be hateful and abominable to God (*Instit.* bk. ii. ch. i. sect. 8).

To redeem man from this state of guilt, and to recover him from corruption, the Son of God became incarnate, assuming man's nature into union with His own, so that in Him were two natures in one person. Thus incarnate He took on Him the offices of Prophet, Priest, and King, and by His humiliation, obedience, and suffering unto death, followed by His resurrection and ascension to heaven, He has perfected His work and fulfilled all that was required in a Redeemer of men, so that it is truly affirmed that He has merited for man the grace of salvation (bk. ii. ch. 13–17). But until a man is in some way really united to Christ so as to partake of Him, the benefits of Christ's work cannot be attained by him. Now it is by the secret and special operation of the Holy Spirit that men are united to Christ and made members of His body. Through faith, which is a firm and certain cognition of the divine benevolence towards us founded on the truth of the gracious promise in Christ, men are by the operation of the Spirit united to Christ and are made partakers of His death and resurrection, so that the old man is crucified with Him and they are raised to a new life, a life of righteousness and holiness. Thus joined to Christ the believer has life in Him and knows that he is saved, having the witness of the Spirit that he is a child of God, and having the promises, the certitude of which the Spirit had before impressed on the mind, sealed by the same Spirit on the heart (bk. iii. ch. 33–36). From faith proceeds repentance, which is the turning of our life to God, proceeding from a sincere and earnest fear of God, and consisting in the mortification of the flesh and the old man within us and a vivification of the Spirit. Through faith also the believer receives justification, his sins are forgiven, he is accepted of God, and is held by Him as righteous, the righteousness of Christ being imputed to him, and faith being the instrument by which the man lays hold on Christ, so that with His righteousness the man appears in God's sight as righteous. This imputed righteousness, however, is not disjoined from real personal righteousness, for regeneration and sanctification come to the believer from Christ no less than justification; the two blessings are not to be confounded, but neither are they to be disjoined. The assurance which the believer has of salvation he receives from the operation and witness of the Holy Spirit; but this again rests on the divine choice of the man to salvation; and this falls back on God's eternal sovereign purpose, whereby He has predestinated some to eternal life while the rest of mankind are predestinated to condemnation and eternal death. Those whom God has chosen to life He effectually calls to salvation, and they are kept by Him in progressive faith and holiness unto the end (bk. iii. *passim*). The external means or aids by which God unites men into the fellowship of Christ, and sustains and advances those who believe, are the church and its ordinances, especially the sacraments. The church universal is the multitude gathered from diverse nations, which though divided by distance of time and place, agree in one common faith, and it is bound by the tie of the same religion; and wherever the word of God is sincerely preached, and the sacraments are duly administered, according to Christ's institute, there beyond doubt is a church of the living God (bk. iv. ch. 1, sect. 7–11). The permanent officers in the church are pastors and teachers, to the former of whom it belongs to preside over the discipline of the church, to administer the sacraments, and to admonish and exhort the members; while the latter occupy themselves with the exposition of Scripture, so that pure and wholesome doctrine may be retained. With them are to be joined for the government of the church certain pious, grave, and holy men as a senate in each church; and to others, as deacons, is to be entrusted the care of the poor. The election of the officers in a church is to be with the people, and those duly chosen and called are to be ordained by the laying on of the hands of the pastors (ch. 3, sect. 4–16). The sacraments are two—Baptism and the Lord's Supper. Baptism is the sign of initiation whereby men are admitted into the society of the church and, being grafted into Christ, are reckoned among the sons of God; it serves both for the confirmation of faith and as a confession before men. The Lord's Supper is a spiritual feast where Christ attests that He is the life-giving bread, by which our souls are fed unto true and blessed immortality. That sacred communication of His flesh and blood whereby Christ transfuses into us His life, even as if it penetrated into our bones and marrow, He in the Supper attests and seals; and that not by a vain or empty sign set before us, but there He puts forth the efficacy of His Spirit whereby He fulfils what He promises. In the mystery of the Supper Christ is truly exhibited to us by the symbols of bread and wine; and so his body and blood, in which He fulfilled all obedience for the obtaining of righteousness for us, are presented. There is no such presence of Christ in the Supper as that He is affixed to the bread or included in it or in any way circumscribed; but whatever can express the true and substantial communication of the body and blood of the Lord, which is exhibited to believers under the said symbols of the Supper, is to be received, and that not as perceived by the imagination only or mental intelligence, but as enjoyed for the aliment of the eternal life (bk. iv. ch. 15, 17).

The incessant and exhausting labours to which Calvin gave himself, could not but tell on the strongest constitution: how much more on one so fragile as his! Amid many sufferings, however, and frequent attacks of sickness, he manfully pursued his course for twenty-eight years; nor was it till his frail body, torn by many and painful diseases—fever, asthma, stone, and gout, the fruits for the most part of his sedentary habits and unpausing activity—had, as it were, fallen to pieces around him, that his indomitable spirit relinquished the conflict. In the early part of the year 1564 his sufferings became so severe that it was manifest his earthly career was rapidly drawing to a close. On the 6th of February of that year he preached his last sermon, having with great difficulty found breath enough to carry him through it. He was several times after this carried to church, but never again was able to take any part in the service. With a noble disinterestedness he refused to receive his stipend, now that he was no longer able to discharge the duties of his office. In the midst of his sufferings, however, his zeal and energy kept him in continual occupation; when expostulated with for such unseasonable toil, he replied, "Would you that the Lord should find me idle when He comes?" After he had retired from public labours he lingered for some months, enduring the severest agony without a murmur, and cheerfully attending to all the duties of a private kind which his

iseases left him strength to discharge. A deep impression ɔems to have been made on all who visited him on his eathbed; they saw in him the noble spectacle of a great pirit that had done its life-work, calmly and trustfully assing through the gate of suffering into the long-desired nd firmly-expected repose of heaven. He quietly expired ı the arms of his faithful friend Beza, on the evening of he 27th of May, in the fifty-fifth year of his age.

Calvin was of middle stature; his complexion was omewhat pallid and dark; his eyes, to the latest clear and ıstrous, bespoke the acumen of his genius. He was sparing ı his food and simple in his dress; he took but little sleep, nd was capable of extraordinary efforts of intellectual toil. Iis memory was prodigious, but he used it only as the ervant of his higher faculties. As a reasoner he has seldom ɔeen equalled, and the soundness and penetration of his udgment were such as to give to his conclusions in practical ɥuestions almost the appearance of predictions, and inspire n all his friends the utmost confidence in the wisdom of iis counsels. As a theologian he stands on an eminence vhich only Augustine has surpassed; whilst in his skill as ın expositor of Scripture, and his terse and elegant style, ıe possessed advantages to which Augustine was a stranger. Iis private character was in harmony with his public eputation and position. If somewhat severe and irritable, ıe was at the same time scrupulously just, truthful, and ıteadfast; he never deserted a friend or took an unfair ıdvantage of an antagonist; and on befitting occasions he could be cheerful and even facetious among his intimates. "I have been a witness of him for sixteen years," says Beza, "and I think I am fully entitled to say that in this man there was exhibited to all an example of the life and death of the Christian, such as it will not be easy to depreciate, such as it will be difficult to emulate."[1] (W. L. A.)

CALVISIUS, Sethus (1556–1617), a German astronomer and chronologer, was born at Groschleben, in Thuringia, in 1556. He studied at Helmstädt, where he made great progress in classical literature, as well as in the sciences in which he afterwards became so distinguished. He was offered a professorship of mathematics at Frankfort, and afterwards one at Wittenberg, both of which he declined. He agreed, however, to conduct the school of music, established at Pforte,—an office which he afterwards exchanged for a similar situation at Leipsic. At Frankfort he published, in 1585, his *Opus Chronologicum*, a work compiled on astronomical principles. He likewise organized a system of chronology, embodying the history of the world, upon an ingenious and original plan, highly commended by Casaubon and Scaliger. This work, which was strongly condemned in the *Index Expurgatorius*, has been frequently reprinted. In 1612 Calvisius published his *Elenchus Calendarii Gregoriani, et duplex Calendarii melioris forma*, in which he attempts to prove the inadequacy of the Gregorian calendar, and proposes to introduce a new system based upon astronomical principles. The only proof now extant of his musical knowledge is his treatise entitled *Melodiæ condendæ ratio*. He died at Leipsic in 1617.

[1] *Vit. Calv. sub fin.* This is the principal source for the facts of Calvin's life. Beza's narrative has been expanded and illustrated from other sources by Dr Henry in his *Leben Calvins*, of which an English translation has appeared in 2 vols. 8vo, by the Rev. H. Stebbing. Audin has written a life of Calvin in French, full of misrepresentations and blunders. A highly respectable work has appeared on the same subject from the pen of M. Dyer, in 1 vol. 8vo. M. Bungener has also recently sent forth a *Life of Calvin*, which has been translated into English, Edin., 1863. Of Calvin's works, two editions appeared at Geneva, one in 12 vols. fol. in 1578, the other in 7 vols. fol. in 1617. An edition, hitherto reputed the best, was published at Amsterdam in 9 vols. fol. in 1671. A new edition in 4to is at present in course of publication, carefully edited by G. Baum, E. Cunitz, and E. Reuss, at Brunswick. An English translation has been issued at Edinburgh in 53 vols. 8vo.

CALYDON (Καλυδών), an ancient town of Ætolia, 7½ miles from the sea, on the River Evenus. It was said to have been founded by Calydon, son of Ætolus; to have been the scene of the hunting, by Meleager and other heroes, of the famous Calydonian boar, sent by Artemis to lay waste the fields; and to have taken part in the Trojan war. In historical times, it is first mentioned (391 B.C.) as in the possession of the Achæans, who retained it for twenty years, by the assistance of the Lacedæmonian king Agesilaus, notwithstanding the attacks of the Acarnanians. After the battle of Leuctra (371 B.C.) it was restored by Epaminondas to the Ætolians. In the time of Pompey it was a town of importance; but Augustus removed its inhabitants to Nicopolis, which he founded to commemorate his victory at Actium (31 B.C.)

CALYPSO, in Grecian mythology, was a daughter of Oceanus and Tethys, or of Nereus, or of Atlas, and reigned in the mythical island of Ogygia. When Ulysses was shipwrecked on her shores, Calypso entertained the hero with great hospitality; and by the united influence of her love and spells, she prevailed on him to remain and share her honours. In this manner seven years had been spent, when Ulysses was seized with an irresistible desire to revisit his native country. Calypso tried every expedient, and even the promise of eternal youth, to induce the hero to remain; and when all her efforts had proved unavailing, and he set sail, grief at his departure occasioned her death. (Hesiod, *Theog.* 359; Hom., *Od.* i. 50, v. 28, vii. 254; Apollod. i. 2, § 7.)

CAM, Diogo, a Portuguese discoverer, of noble birth, *belonging to the latter half of the 15th century, is famous* for having carried on, under Alphonso V., the discoveries in Western Africa commenced by Don Henry. He sailed round capes Gonçalvez and Catharina; and having obtained great influence with the king of Congo, opened up that country for the introduction of Christianity. On his first voyage (1484) he was accompanied by Martin Behem, the astronomer and cosmographer. Subsequently Cam penetrated as far as 22° S. lat.

CAMALDULIANS, Camaldunians, or Camaldolites, an order of religious persons, founded by Romuald, an Italian, in the beginning of the 11th century, in the desolate waste of Camaldoli, or Campo Malduli, on the lofty heights of the Apennines. Their rule was that of St Benedict; and their houses were never erected at less than five leagues from cities. The monks were divided into cenobites and eremites. The Camaldulians, till the close of the 11th century, were called generally Romualdins; previously, Camaldulian was a particular name for those of the desert Camaldoli. Guido Grandi (1671–1742), a Camaldulian monk, and mathematician to the grand duke of Tuscany, published *Camaldulian Dissertations*, on the origin and establishment of this order. Pope Gregory XIII. was a Camaldulian.

CAMARINA, an ancient city of Sicily, situated on the south coast, near the mouth of the Hipparis or Fiume di Camarana, as it is still called, about 20 miles E. of Gela or Terranova. It was originally founded by the Syracusans in the 6th century B.C., but was shortly afterwards destroyed by the mother city, because it had thrown off its allegiance. Restored in 495 B.C. by Hippocrates of Gela, it was again depopulated by Gelon, the conqueror of Syracuse, and did not receive a permanent establishment till 461. During the next century the mainspring of its political action was usually antipathy to Syracuse, but on the Athenian invasion it ultimately sent assistance to the beleaguered city. The Carthaginians struck a severe blow at its prosperity in the 5th century B.C., and in 258 a large part of its inhabitants were sold as slaves by the Roman consuls. The town continued to exist in the 2d century of the Christian era, and its site is still marked by a considerable mass of ruins. Μὴ κίνει

Καμάριναν, "Do not stir Kamarina," a proverb somewhat equivalent to our advice to "let well alone," is said to have been originally the answer of the Delphic oracle to the citizens when they consulted as to the draining of a neighbouring lake.

CAMBACÉRÈS, JEAN JACQUES REGIS DE (1753–1824), an eminent French statesman under the first republic and the first empire, was born at Montpellier the 18th October 1753, of an old and distinguished family. Being destined for the profession of law, he began his studies in that department at an early age, and was soon recognized as one of the ablest jurists in France. And as his legal learning was one of the main sources of his fame, so it was his chief means of rendering service to his country. Cambacérès was a decided though moderate disciple of the new principles now everywhere diffused in France, and on the assembling of the States-general in 1789 was chosen as a second representative for the nobility of the district of Montpellier. The right of Montpellier to send a second noble deputy was disputed, and Cambacérès did not sit. But he was a member of the National Convention in 1792. Foreseeing the violent courses into which the Convention should be impelled, Cambacérès, from principle as well as necessity, held aloof, and sought to avoid the perils and excesses of the time by confining himself to the neutral province of jurist and legislator. The trial of the king, however, compelled him to declare himself. In the first place, he maintained that the Convention was not competent to try the king; and when the trial had been decided on, he insisted that all latitude of defence ought to be accorded to the royal counsel. As to the sentence, he found the king guilty, and worthy of the punishment due to one who had conspired against his country; but moved for delay in the execution of it, till peace should be restored, or the French soil invaded. This moderation made Cambacérès "suspect" in the eyes of the Mountain, and he confined himself more circumspectly than ever to his proper work of revising and codifying the new laws. On the downfall of Robespierre in 1794, he was a leading man in the restoration of a milder régime. He was sometime president of the Convention, and, subsequently, president of the Committee of Public Safety, in which capacity he helped to the conclusion of peace with Prussia and Spain. Under the Directory he again fell under the suspicion of the extreme party, and was obliged to retire from the presidency of the Five Hundred, to which he had been called. He took no part in the revolution of the 18th Brumaire (9th November 1799), which overturned the Directory and set up the consulate; but Napoleon had such confidence in him that he made him second consul. This confidence Cambacérès continued to enjoy all through the consulate and the empire. On the establishment of the empire he became arch-chancellor, being life-president of the Senate, and the right-hand man of Napoleon in the civil administration generally. While loyal to his master, his influence was on the whole beneficial to France. He took an important part in the redaction of the Code Napoléon, tried to dissuade Napoleon from the murder of the Duc d'Enghien and from the disastrous campaigns of 1812 and 1813, and only gave in his adhesion to the act of abdication of 1814 when resistance was manifestly hopeless, while he resumed office with reluctance during the Hundred Days.

After the final restoration of Louis XVIII. in 1815, Cambacérès again became an object of persecution, this time as a regicide, and was obliged to retire into Belgium. A royal decree of 1818 restored him to all his civil and political rights, but he did not again emerge from private life. He died in 1824. Cambacérès was a great contrast to most of the leading men in the stormy days of the Revolution. He was moderate in his opinions and in his advocacy of them; he had a clear, penetrating and luminous understanding; and was a great master of senatorial eloquence. He had been created duke of Parma in 1808, and by this name is sometimes known in history.

CAMBALUC is the name by which, under sundry modifications, the royal city of the Great Khan became known to Europe during the Middle Ages, that city being in fact the same that we now know as Peking. The word itself represents the Mongol *Kaan-Baligh*, "the city of the khan," or emperor, the title by which Peking continues, more or less, to be known to the Mongols and other northern Asiatics.

A city occupying approximately the same site had been the capital of one of the principalities into which China was divided some centuries before the Christian era; and during the reigns of the two Tartar dynasties that immediately preceded the Mongols in Northern China, viz., that of the Khitans, and of the *Kin* or "Golden" khans, it had been one of their royal residences. Under the names of Yenking, which it received from the Khitan, and of Chungtu, which it had from the Kin, it holds a conspicuous place in the wars of Chinghiz Khan against the latter dynasty. He captured it in 1215, but it was not till 1264 that it was adopted as the imperial residence in lieu of Kara Korum in the Mongol steppes, by his grandson Kublai. The latter selected a position a few hundred yards to the N.E. of the old city of Chungtu or Yenking, where he founded the new city of *Ta-tu* ("great capital"), called by the Mongols *Taidu* or *Daitu*, but also *Kaan-baligh*; and from this time dates the use of the latter name as applied to this site.

The new city formed a rectangle, enclosed by a colossal mud-rampart, the longer sides of which ran north and south. These were each about 5⅓ English miles in length, the shorter sides 3¾, so that the circuit was upwards of 18 miles. The palace of the khan, with its gardens and lake, itself formed an inner inclosure fronting the south. There were eleven city gates, viz., three on the south side, always the formal front with the Tartars, and two on each of the other sides; and the streets ran wide and straight from gate to gate (except, of course, where interrupted by the palace-walls), forming an oblong chess-board plan.

Tatu continued to be the residence of the emperors till the fall of the Mongol power (1368). The native dynasty (Ming) which supplanted them established their residence at *Nan-king* ("South-Court"), but this proved so inconvenient that the second sovereign of the dynasty reoccupied Tatu, giving it then, for the first time, the name of *Pe-king* ("North-Court"). This was the name in common use when the Jesuits entered China towards the end of the 16th century, and began to send home accurate information about China. But it is not so now; the names in ordinary use being *King-cheng* or *King-tu*, both signifying "capital." The restoration of Cambaluc was commenced in 1409. The size of the city was diminished by the retrenchment of nearly one-third at the northern end, which brought the enceinte more nearly to a square form. And this constitutes the modern (so-called) "Tartar city" of Peking, the south front of which is identical with the south front of the city of Kublai. The walls were completed in 1437. Population gathered about the southern front, probably using the material of the old city of Yenking, and the excrescence so formed was, in 1544, enclosed by a wall, and called the "outer city." It is the same that is usually called by Europeans "the Chinese city." The ruins of the retrenched northern portion of Kublai's great rampart are still prominent along their whole extent, so that there is no room for question as to the position or true dimensions of the Cambaluc of the Middle Ages; and it is most probable, indeed it is almost a necessity, that the present palace stands on the lines of Kublai's palace.

The city, under the name of Cambaluc, was constituted into an archiepiscopal see by Pope Clement V. in 1307, in favour of the missionary Franciscan John of Montecorvino; but though some successors were nominated it seems probable that no second metropolitan ever actually occupied the seat.

Maps of the 16th and 17th centuries often show Cambaluc in an imaginary region to the north of China, a part of the misconception that has prevailed regarding Cathay (see CHINA). The name is often in popular literature written Cambalu, and is by Longfellow accented in verse *Cămbălŭ.* But this spelling originates in an accidental error in Ramusio's Italian version, which, till lately, was the chief channel through which Marco Polo's book was popularly known. The original (French) MSS. all agree with the etymology in calling it Cambaluc, which should be accented *Cămbălŭc.* (H. Y.)

CAMBAY, or KAMBAY, a town of Western India, in Guzerat, or the northern division of the province of Bombay, and forming the capital of the native state of the same name, which has an area of about 350 square miles, and a population of about 175,000. It is situated on the River Mahi, at the upper part of the Gulf of Cambay, 230 miles N. of Bombay, in 22° 18′ N. lat. and 72° 39′ E. long. It is supposed to be the *Camanes* of Ptolemy, and was formerly a very flourishing city, the seat of an extensive trade, and celebrated for its manufactures of silk, chintz, and gold stuffs; but owing principally to the gradually increasing difficulty of access by water, its commerce has long since fallen away, and the town has become poor and dilapidated. The tides rise upwards of 30 feet, and at high water ships anchor near the town. The trade is chiefly confined to the export of cotton. The town is celebrated for its agates and carnelians, which are wrought into a variety of trinkets of reputation principally in China. The houses in many instances are built of stone (a circumstance which indicates the former wealth of the city, as the material had to be brought from a very considerable distance); and a brick wall, three miles in circumference, surrounds the town, enclosing four large reservoirs of good water and three bazaars. To the south-east there are very extensive ruins of subterranean temples and other buildings half-buried in the sand by which the ancient town was overwhelmed. These temples belong to the Jains, and contain two massive statues of their deities, the one black, the other white. The principal one, as the inscription intimates, is Pariswanath, or Parswanatha, carved in the reign of the Emperor Akbar; the black one has the date of 1651 inscribed. It is supposed that Cambay about the 5th century was the capital of the Hindu emperors of Western India. In 1780 it was taken possession of by the army of General Goddard, was restored to the Mahrattas in 1783, and was afterwards ceded to the British by the Peishwa under the treaty of 1803. The nawab, who is one of the 153 feudatory princes of British India by *Sunnud* or patent, pays £5876 of annual tribute to the viceroy of India from his revenue of £35,000. His military establishment consists of 800 horse and foot, who are employed indiscriminately in revenue, police, and miscellaneous duties; and a few pieces of ordnance complete his resources.

The GULF OF CAMBAY, which is shallow and abounds in shoals and sand-banks, penetrates the coast of India for about 80 miles. It is supposed that the depth of water in this gulf has been decreasing for more than two centuries past. The tides, which are very high, run into it with amazing velocity, but at low water the bottom is left nearly dry for some distance below the latitude of the town of Cambay. It is, however, an important inlet, being the channel by which the valuable produce of central Guzerat and the British districts of Ahmedabad and Broach is exported; but the railway from Bombay to Baroda and Ahmedabad, near Cambay, is gradually attracting the trade to itself. The gulf extends between 21° and 22° 10′ N. lat., and 71° 50′ and 72° 40′ E. long.

CAMBERT, ROBERT (1628–1677), the earliest composer of French operas, was born at Paris in 1628. His master for the clavecin, and probably also for composition, was Chambonnières. He was organist of the church of St Honoré, and also held the office of musical superintendent to Queen Anne of Austria, mother of Louis XIV. His earlier works, the words of which were furnished by the Abbé Perrin, continued to be performed before the court at Vincennes, till the death of his patron Cardinal Mazarin. Displeased at his subsequent neglect, and jealous of the favour shown to Lulli, who was musical superintendent to the king, he went, in 1673, to London, where he was appointed soon after his arrival master of the band to Charles II. One at least of his operas, *Pomone*, was performed in London under his direction, but it did not suit the popular taste. His principal operatic pieces were entitled *Ariadne ou les Amours de Bacchus*, *Pomone*, and *Les Peines et les Plaisirs de l'Amour.* Cambert died in London about 1677.

CAMBODIA, more properly CAMBOJA, or KAMBOJA, a very ancient kingdom of South-eastern Asia, still subsisting in decay. As now limited the territory of Camboja forms a rough parallelogram, consisting in large part of alluvial plain, lying athwart the lower course of the Mekong or Great Camboja River, just above the Delta. The greatest length of the territory runs from W. to E., covering a little more than 3½° of longitude, viz., from about 103° E. long. to 106° 40′. The mean breadth from S. to N. is a little over 2° of latitude, extending on the western coast from 10° 30′ N. lat. to 11° 45′, and on the little known eastern frontier from about 11° 35′ to 13° 40′. On the N. it is bounded by provinces which the Siamese have wrested from Camboja; on the E. by Cochin-Chinese territory; on the S. by the Delta Provinces first taken by Cochin-China from Camboja, and then by the French from Cochin-China; on the W. by the Gulf of Siam, along which it extends for 200 miles, now its only seaboard.

Both the ethnology and the early history of Camboja partake of the obscurity that hangs over Indo-China generally. But traditions of the ancient grandeur of the kingdom are borne out by the recent exploration of numerous architectural remains of extraordinary extent and magnificence within its former limits. Some important notices are found in Chinese annals, and more information is to be expected when numerous existing inscriptions shall have been successfully interpreted.

The name given by the people of Camboja to their own race is *Khmĕr*, a name which was known and used by early Arab voyagers and geographers under the form *Kŏmâr*, and noted by them as a country famous for aloes-wood; it has, however, been imbroiled in much confusion both by them and by their commentators. There is a persistent and apparently well-founded tradition among the Khmér, that before their own immigration, as they say from the north, the *Tsiam* or *Champa* race were in possession of the soil, whilst the Khmér themselves seem to have preceded the descent of the *Thai* race, to which the people of Siam and Laos belong.

Local written legends again appear to speak of two early immigrations from Gangetic India. We know that the Pali-Buddhistical annals of Ceylon record that at the conclusion of the third great synod of the Buddhist church, held at Palibothra, in the year 302 after Buddha (corresponding, according to ordinary Cevlonese reckoning, to 241 B.C., but as corrected by Professor Max Müller to 175 B.C.), a mission was despatched to the region of

Sûvarna-Bhumi—i.e., Aurea-Regio or *Chryse;* and this record may have been the real basis of the earlier Cambojan tradition. But it must not be forgotten that in Ptolemy's map of the Indo-Chinese coast are found many Sanskrit names, indicating the existence of Hindu settlements at least as early as the 1st century of our era. The name of *Kamboja*, though in later days we find it subjected to fantastic charade-making after the Chinese fashion of etymology,[1] appears to be simply the transfer of a name famous in old Indian literature as that of a race and region on the N.W. of the Panjâb, in or near the present Chitrâl. Such transfers were common, and many survive in Indo-Chinese use or memory to this day.[2]

It is a singular circumstance that some of the Cambojan legends collected by Bastian—indications of which were also recorded by missionaries two centuries ago—bring the second Indian immigration from a western region called *Rom* or *Roma-visei*. This will be noticed again.

Like other Indo-Chinese states Camboja possesses written annals; but these do not commence till 1346 A.D. Hence they only take up the history of the kingdom when its power, and perhaps its civilization, were already past their climax.

From the Chinese annals older information is obtained. These mention, under the name of *Fu-nan*, and as early as the 12th century B.C., a kingdom embracing what afterwards became Camboja; and the Emperor Hiao-wuti of the Han dynasty is alleged to have made Funan tributary, along with adjoining countries, *circa* 125 B.C. Some two centuries later the same annals place an immigration under a foreign prince, who became the founder of a dynasty, and is perhaps to be identified with the Indian leader of the native legends. The fourth king of this dynasty—say in the latter part of the 2d century—makes extensive conquests over the adjoining kingdoms and coasts, and takes the name of *Ta-wang* ("great king"), probably a translation of the Indian title *Mahâ-râja*, which reappears some centuries later in Arab narratives as that of the King of the Isles. It is alleged, too, at this time, that the people of *Ta-tsin, i.e.*, of the Roman empire, including Western Asia, frequented the ports of Funan for trade. This circumstance is highly probable when we consider that Ptolemy attests such voyages as having been made at least *occasionally*, in the 1st or 2d century, whilst the Arab narratives show that they were habitual in the 9th.

Cambojan legend, like that of nearly all the Indo-Chinese countries, couples the introduction of Buddhism (perhaps rather its re-introduction) with the name of Buddhaghosha. However that may be, it is about the 1000th year of Buddha (*i.e.*, according to the ordinary calculation 457 A.D.), and near the date usually assigned to Buddhaghosha, that the traditions place a great king, *Phutamma Surivong, i.e.*, Padma Suryavansi; and it is at this epoch of the 5th and 6th centuries that Garnier is inclined to place the great kings, who were the founders of the older architectural monuments. Fergusson would place these several centuries later, but the whole subject of their chronology is as yet too obscure. From about this time the kingdom is known in Chinese records as *Chinla*, and to those days of splendour may be referred an old Chinese proverbial saying, "Rich as Chinla." It appears long to have ruled over the valley of the Menam (since the 14th century the seat of Siamese monarchy), and perhaps at one time to the shores of the Bay of Bengal. In the reign of Prakrama Bahu of Ceylon (1155 A.D.) we hear, in the annals of that island, of his intercourse with Camboja (*Jour. As. Soc. Bengal*, vol. xli. p. 198).

A very remarkable account of Chinla or Camboja, by an envoy sent from Peking shortly after the death of Kublaï Khan (viz., in 1295–1297), has been translated by Abel-Rémusat, and affords us a strange peep into the midst of a civilization now in the profoundest decay. The accuracy of his details regarding topography and surviving monuments of architecture attests the writer's truthfulness. The court and capital are described as very splendid, whilst (as in all Indo-Chinese countries) some traits of the deepest barbarism in manners show themselves. The kingdom possessed many fortified cities; but its power was already in decline, for it had not long before suffered from one of those invasions of the Thai which have ever since been wearing it away. Again and again such invasions and temporary occupation were repeated, especially after the foundation of the Siamese monarchy by another branch of the Thai in 1350.

The Portuguese found their way to Camboja not long after the conquest of Malacca, and the kingdom still retained a good deal of the shell of its old splendour. Yet its native force appears by this time to have been in reality almost burnt out; and towards the end of the 16th century the land swarmed with foreign adventurers, both European and Asiatic, among the latter of whom Japanese were prominent. At the instigation of some of these adventurers we find the Spanish authorities at Manilla (1594–1598) engaging in "fillibustering" expeditions to Camboja, with little result. Somewhat later the Portuguese had factories in the country, and then the Dutch (1635). Notices of English trade with Camboja appear as early as 1616. In 1641 Gerard van Wusthoff of the Dutch factory conducted a remarkable expedition up the Great River to Vienchang, the capital of one of the Laos states, about 1000 miles from the sea,—a feat never repeated till the French mission of 1866–68. In 1643 Mynheer Regemortis, envoy from Batavia, with all the Europeans of the factory, on his way to court, were assassinated under Portuguese instigation, and this put a discreditable and too characteristic end to the official relations of Europeans with Camboja. The English established a factory at Pulo Condore, a group of islands off the coast of the Cambojan delta in 1702, but this also came to a speedy end in the massacre of its members by the Macassar sepoys of the garrison. The first missionary who entered Camboja was Gaspar da Cruz, a Dominican, in 1555. He has left some curious particulars which are given by Purchas.

Camboja continued to be ground between the two millstones of Siam and the now rising kingdom of Cochin-China. The former about 1690 annexed large tracts on the N.W., augmented a century later, and again in 1810–12, by seizures which embraced the districts adjoining the Great Lake, at the very heart of the old monarchy; the latter in the middle of the last century absorbed the whole of the Delta; and Camboja was thus reduced to its present narrow limits. In 1846 a king was enthroned under the joint investiture of Siam and Cochin-China. The French invasion of the Anamite provinces in the Delta took place in 1859, and these were formally ceded in 1862. Meantime Camboja seemed about to be finally swallowed up by Siam. It was manifest, however, that the prospects of the new French possession would be materially restricted if all above the Delta were Siamese; and France began to claim the character of protector of Camboja. In 1864 the king, Morodam, was solemnly crowned in the presence of a French and of a Siamese representative; and a treaty was

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[1] The syllables of *Kamboja* have been tortured by the later natives to mean "born of the waters," "race of Kam (Khmér)," and what not. The modern Chinese have corrupted *Kamboja* through *Kan-phu-chê* into *Tung-po-chai*, probably to meet some fancy of a similar kind.

[2] The occurrence of the name *Camboja* on one of the *repliche* of the inscriptions of Asoka, in connection with the names of regions in the extreme south of India, has lately raised a question whether the Indo-Chinese Camboja did not even then exist.

concluded, placing the kingdom formally under joint protection of those two powers, but practically of France. The presence of a Siamese resident at the court ceased; and thus a reprieve at least was given to this ancient monarchy.

Capitals and Seaports.—The ancient capital of Camboja in its splendour was *Angkor*, of which we shall speak below, abandoned in consequence of its exposure to Siamese aggression in 1388, but briefly reoccupied in 1437. In 1388 the court moved to *Basan* or *Boribun*, on the S.W. shore of the lake, and a few years later to *P'nompenh*, corruptly in some books called *Calompé*, at the confluence of the outlet of the Great Lake with the Mekong. This appears to be the place named by some of the old writers *Chordamuco*. About 1528 it was established at *Lovek* (called by Valentijn *Eauwek*), near the west side of the issue from the lake; then at *Puntenang* or *Pontaipret* opposite Lovek. Udong, a few miles north of the confluence, became the capital in 1739, and so continued down to 1866, when it was again transferred to P'nompenh. The chief port of foreign trade in the 17th century was *Potaimat*, called by foreigners *Ponteamas*, replaced afterwards by *Kangkao* or *Atien* on the same bay. But both were in the territory taken by the Cochin-Chinese, and now French. Since the annexations by Siam and Anam Camboja has only one port, *Kâmpot*. The trade is chiefly in Chinese hands. Between this and the rich alluvial tract round the capitals a high range of hills has to be passed, but there is a cart road the whole way to P'nompenh.

Chief Geographical Features.—The great river *Mekong*, known also as the Camboja River, a name bestowed when its delta yet belonged to Camboja, flows through the existing territory for about 250 miles, from N.E. to S.W. This river as a whole will be better dealt with elsewhere (see MEKONG). The next main feature of the present limited territory is the "Great Lake," as it is called by the Cochin-Chinese (*Bienhoa*), or "Freshwater Lake" of the Cambojans (*Talé-Sab*),—by the Malays styled the Lake of Sri Râma. This lake is of the nature of those sheets of water which in Bengal are called *jhîls*, viz., a shallow depression in an alluvial plain, retaining a part of the annual overflow of the rivers throughout the year, and hence subject to great variations in depth and extent. In the rains it is said to have a length of about 100 miles (N.W. to S.E.) with a breadth of one-third as much. Its average depth in the dry season is only 4 feet. The Udong River, communicating between the lake and the Mekong, fills a channel of great breadth. Its waters change their direction half-yearly, from June to December filling the lake from the Mekong, and from December to June draining the lake into the Mekong. The lake is an object of superstitious regard to the people, and the fishery therein is the most important event in their annual life. It is carried on in the dry season, during which time extensive pile-villages are erected in the lake, where the drying and salting of the fish is carried on. The dried fish is exported largely to Cochin-China, as well as live fish in cages. Much also is converted into oil.

Natural Productions and Exports.—The *elephant* may be regarded as the characteristic animal of Camboja. Wild herds are numerous, and frequent the shores of the lake in the dry season. The tamed animals are by no means so well trained as in India, but they are the chief beasts of burden, and a few years ago did not cost more than £10 or £12. The *rhinoceros* also abounds (the species we do not find stated) about the foot of the mountains north of the lake. Strong and handsome *ponies* are bred, much in demand at Bangkok. Among wild animals there are said to be three species of *wild cattle*.

The Chinese envoy of 1295-97 mentions among Cambojan exports rhinoceros' horns, gamboge, cardamoms, and eagle-wood; and these are still among the most characteristic. Though the gum called *gamboge* derives its name from Camboja, and is chiefly supplied by that country, the tree (*Garcinia Morella*) does not appear to have been seen in its native localities by any botanist. Dr Thorel, of the French expedition, indicates its habitat as in the N.W. of the old Cambojan territory, about Korat, now subject to Siam. The *cardamoms* (*Amomum villosum*, Louveiro) are produced in the mountains not far from the lake. *Eagle-wood* (or *Aloes-wood*) appears to be the result of disease, forming internal cavities in the soft white wood of *Aquilaria agallocha*, and is obtained by splitting the tree,—its probable existence in any tree being recognized by indications known to the collectors. It is now found chiefly near the coast of the Gulf of Siam, about Chantibun (now Siamese), and is said to be common in the island of Kotran, or Phukok, off Kampot. The names *eagle-wood*, *agila*, &c., are corruptions from the Sanskrit *Aguru*, and have nothing to do with eagles.

Other vegetable products are nutmeg, liquorice, caoutchouc and gutta-percha, tobacco, sapan-wood, pepper, rice, cotton, &c., with benzoin from the Upper Mekong. Additional exports of sorts are hides and horns, tortoise-shell, lac, ivory, and dried elephant flesh. Iron of excellent quality is smelted and wrought by some of the hill tribes.

People, Government, and Language.—Of the numerous wild, or we should rather say *illiterate*, tribes on the borders of the Cambojan plain, and still imperfectly known, we cannot speak in our limited space. The Cambojans proper, or *Khmër*, differ much from both Siamese and Cochin-Chinese. They are described as tall, well and strongly made, showing less of Mongoloid feature than any of the better known nations of Indo-China; good-natured but apathetic, and leaving all the trouble and gains of trade to Chinese, Anamites, and Malays. Their religion is Buddhism of the usual Indo-Chinese type. But like the other races of that region they call in the devil-dancing medicine-man in illness. They cut the hair short, leaving a top-tuft, and wear the *langûti*, or loin-cloth, tucked between the legs, using that Hindu name for it.

There are some 2000 Roman Catholic Christians in the country, and some considerable number of Malay and Tsiam Mahometans. The Malays are chiefly on the coast, and claim to be very ancient settlers.

The government is an absolute monarchy, after the usual Indo-Chinese kind, with a second king or cæsar, the *Yuva-râja* of ancient India, known by a corruption of that title.

The language is placed by the late Mr Logan in his "Mon-Anam" class. But it appears to differ materially from the Anamite, as well as from other purely monosyllabic languages of Indo-China. These, like the Chinese, employ a variety of so-called *tones*, or inflexions of voice, by which different meanings of the same monosyllable are discriminated,—the Anamite having six such tones. The Cambojan is without these, being spoken, as a missionary expresses it, *recto tono*. The numeration is stated by Garnier to present traces of a quinary system, but the vocabulary which he gives hardly confirms this. The letters are an ornamental form of the Pali, which has been the foundation of all the Indo-Chinese alphabets. An older form, illegible to the modern priests, is used in the inscriptions.

Architectural Antiquities. As already indicated, there are of the highest importance and interest. They are found in some forty or more known localities, and some as far north as Suren in the Korat district, now Siamese (14° 47′ N. lat.) Indeed the most important remains are all in what is now Siamese territory, north of the Great Lake. The remains embrace walled cities of large extent; palaces and temples, stupendous in scale and rich in design, and often most elaborately decorated with long galleries of

storied bas-reliefs; artificial lakes enclosed by walls of cut stone; stone bridges of extraordinary design and excellent execution; elaborate embanked highways across the alluvial flats, &c. Were it possible to reconcile the geography, they would almost justify the extravagant fictions of Mendez Pinto regarding the palaces and temples of Timplan and Timagogo.

About fifteen miles north of the lake, buried in forest, is the ancient capital, commonly called *Angkor* or *Nakhon* (both corruptions of the Indian *Nagara*) *Thom*, or "the Great City," the proper old name of which was *Inthapataburi*, *i.e.*, Indraprasthapuri, after the capital of the Pandus in the ancient India of the Mahâbhârat. Mouhot and Thomson have by some misapprehension greatly exaggerated its size; but its walls do in fact form a quadrangle of nearly 8½ miles in circuit and 30 feet in height, surrounded by a very wide ditch. There are five gates (two on the east), of very grandiose though fantastic architecture. About five miles south of the city is the great temple called *Nakhon Wat*, *i.e.*, "the city monastery," one of the most extraordinary architectural relics in the world.

This also is enclosed by a quadrangular wall of 3860 yards in compass, outside of which is a wide ditch. We cannot attempt to describe this edifice with its corridors, sculptures, and towers rising to 180 feet and upwards. Much in the detail is Indian; much that is but obscurely traced as yet in India connects itself with other remains in Indo-China and in Java; much again is unique. One remarkable point is the *Roman-Doric* character of the enriched pilasters which form a feature frequently recurring; this, too, has parallels, though not quite so striking, in Ceylon and in mediæval Burmese remains.

Some remarkable features of the Camboja monuments are distinctly mentioned in the Chinese mediæval narrative, but there is apparently no notice of the Nakhon Wat. If force is to be attached to this omission, it will indicate the date of that building as between 1296 and 1352, the date of the first great Siamese invasion. We are not yet in a position to say with certainty to what worship they were dedicated, though inclining to the view of Garnier, who regards them as belonging to Buddhism, the still existing worship of the nation; and *some* of the temples are certainly Buddhist. Mr Fergusson dissents, and regards the great temples as monuments of serpent-worship,—though admitting doubt.

Though the existence of these remarkable ruins had been quite forgotten till what may be called their rediscovery, of which the first distinct account was given by M. Mouhot in 1859, they had been known to some of the early Jesuit missionaries, who speak of their "discovery in 1570;" and a notice of them from such a source will be found in Zedler's *Universal Lexicon* under "Cambodscha" (1733). Father Ribadeneyra (1601) says a legend ascribed the erection to Alexander the Great. This must have originated with the Malays, among whom Iskandar and the "Alexander Saga" were familiar and popular. And to the same communication may perhaps be due that strange introduction of *Rome* into the legendary history. This would then be Rome in its Mussulman sense,—*Rûm*—*i.e.*, Greece or Turkey.

See Garnier, *Voyage d' Exploration en Indo-Chine*, Paris; Cortambert et de Rosny, *Tableau de la Cochin-Chine*, Paris 1862; Bastian, *Reise*, ii. and iv.; Mouhot's *Travels*, 1864; *The Philippine Islands*, &c., by Antonia de Morga, Hakluyt Soc. 1868; *Cambodia and its Races*, by G. Thomson; *Antiquities of Cambodia*, by J. Thomson; Fergusson's *Hist. of Architecture*, vol. ii., and *Tree and Serpent Worship*; Crawfurd's *Mission to Siam and Cochin-China*; Abel-Rémusat, *Nouv. Melanges Asiat.* vol. i. 100; *Calendar of State-Papers, East Indies*, 1862; Purchas, vol. iii., &c. (H. Y.)

CAMBORNE, a small town in the county of Cornwall, about 13 miles by rail S.W. of Truro. It is a neatly-built place, and stands in the immediate neighbourhood of some of the most productive tin and copper mines in the county, which afford employment to most of the inhabitants. It has a handsome parish church, in the later Gothic style, restored in 1862. Population in 1871, 7757.

CAMBRAY, in German Kamerik, or Kambryk, a fortified town of France, in the department of Nord situated on the right bank of the Scheldt, 32 miles S. of Lille, in 50° 10′ N. lat. and 3° 14′ E. long. It is well built, contains a large number of ancient gabled houses, and is surrounded by strong walls flanked with round towers. The principal building is the Cathedral of St Sepulchre, occupying the site of an earlier structure, which was greatly damaged during the French Revolution, and suffered still more severely from a conflagration in 1859. It still contains a monument by David to the memory of Fénelon, but the tomb in which the archbishop was buried was broken open in 1793, and his coffin melted into bullets. Of the old archiepiscopal palace the only thing left is a Renaissance portal; and the archbishop now has his residence in what was formerly the convent of the Benedictines. Besides these may be mentioned the church of St Gery, and the belfry of St Martin; the town-house, dating from 1873; the citadel; and the public library, containing upwards of 35,000 volumes, in what was formerly the church of the hospital of St John. Cambray is the chief town of an arrondissement, and has judicial and commercial tribunals of the first instance. A college, two theological seminaries, a medical school, and a school of design are its chief educational establishments; it has also various learned societies. The town has long been famous for its manufacture of fine muslin, to which it gave the name Cambric; and it also contains manufactories of cotton cloth, lace, and thread, as well as sugar-factories, oil refineries, distilleries, breweries, and other industrial establishments. Its trade consists of grain, wine, hemp, hops, cattle, butter, and coal. The Scheldt begins to be navigable at the town, and communicates with St Quentin by means of a canal. Population in 1872, 22,897.

Cambray is the ancient Nervian town of *Camaracum*, which is first mentioned in the Antonine Itinerary. In the 5th century it was the capital of the Frankish king Ragnachar. Fortified by Charlemagne, it was captured and pillaged by the Normans in 870, and unsuccessfully besieged by the Hungarians in 953. During the 10th, 11th, and 12th centuries it was the scene of frequent hostilities between the bishop and his supporters on the one hand and the citizens on the other; but the latter ultimately effected their independence. In 1478 Louis XI., who had obtained possession of the town on the death of the last duke of Burgundy, handed it over to the emperor, and in the 16th century Charles the Fifth caused it to be fortified with a strong citadel, for the erection of which the castles of Cavillers, Escaudœuvres, and many others were demolished. From that date to the peace of Nimeguen, which assigned it to France, it frequently passed from hand to hand by capture or treaty. In 1793 it was besieged in vain by the Austrians. The League of Cambray is the name given to the alliance of Pope Julius II., Louis XII., Maximilian I., and Ferdinand the Catholic against the Venetians in 1508; and the Peace of Cambray, or as it is also called, the Ladies' Peace, was concluded in the town by Louise of Savoy, mother of Francis I., and Margaret of Austria, aunt of Charles V., in name of these monarchs. The bishopric of Cambray dates from the 5th century, and it was erected in 1559 into an archbishopric, which continued till the Revolution, and has since been restored. The bishops received the title of count from the Emperor Henry I., and in 1510 were raised to the dignity of dukes, their territory including, besides the town itself, the district called Cambresis.

CAMBRIDGE, COUNTY OF, one of the smaller English counties, belonging to the South Midland division of England, is about 45 miles in length and 30 in breadth. It comprises 17 hundreds, and the boroughs of Cambridge and Wisbeach. There are in the county, which is embraced within the diocese of Ely, 172 parishes and townships, besides parts of parishes. It contains, according to the census of 1871, 524,926 statute acres. It is divided by the old course of the River Ouse into Cambridge proper and the

Isle of Ely. Until the year 1857 the Isle of Ely was practically a county palatine, like the county palatine of Chester and the bishopric of Durham, a distinct enclosure within the county. The liberty of the Isle of Ely has its court of quarter sessions, a separate commission of the peace, and its own county rate. The county, which is purely agricultural, and for the most part arable, presents a vast land expanse, with little that is picturesque and with no claims to fine scenery, but imposing to the summer tourist by the frequent pollarded watercourses, the heavy crops of grain, and the immense dome of sky.

Cambridgeshire evidently once formed part of the country of the Iceni. The Icenhilde, always a British way, and never a via strata, was most probably derived from the same root. The country is rich in Roman roads and other remains, and some of the Roman roads were doubtless formed on old British tracks. (For the ancient roads consult Professor Babington's *Monograph.*) Cambridgeshire became a dependency of the kingdom of East Anglia. It was included in the Danelagh, though how far it was colonized by Northmen is uncertain. According to Henry of Huntingdon, in the war against the Danes, when the English fled the men of Cambridgeshire resisted most manfully. During the period of the Conquest, the siege and capture of the Isle of Ely is the most remarkable event; the sea country was the last that yielded to the Conqueror, and the half-legendary Hereward is the last English hero of the conflict. In the time of Stephen, in the time of John, and in the time of the Barons' War in the reign of Henry III., the Isle of Ely emerges repeatedly into notice. The splendid foundations of Etheldreda and her sister, with the rising colleges of the university of Cambridge, drew pilgrims to the district from all parts of the country. In the Civil War Cambridgeshire belonged to the associated counties, and had no actual share in the conflict. Cromwell possessed a considerable estate in the Isle of Ely, and lived in the rectory house of Ely till elected member for Cambridge. He became governor of Ely, and his son Henry died in the neighbourhood (Carlyle's *Cromwell*). King Charles, after his seizure at Holdenby, was brought to Childerly near Cambridge, and was taken thence to Newmarket, near which the Parliamentary army was encamped under Fairfax and Cromwell.

The drainage of the Cambridgeshire fens forms one of the most remarkable chapters of the industrial history of the country. All the northern portion of the county, at the junction of the counties of Lincoln, Huntingdon, Cambridge, and Norfolk, is part of the vast district known as the Great Level of the Fens. A large province of 680,000 acres of the richest land in England has been reclaimed from the sea and preserved by continual watchfulness, as completely as is the case in the opposite kingdom of Holland. The great works which have reclaimed the land were mainly due to Cornelius Vermuyden, the Dutchman, knighted by Charles I., and the Dutch and Flemings he employed, and in more recent times to James Rennie, the eminent engineer. The chief promoters were five successive earls of Bedford, who have given their name to the great Bedford Level. From the earliest times, however, there had been conflicts between the encroaching waters and the inhabitants of the invaded shores. The Romans, who left few great works unattempted, reclaimed much of the rich silt and soil deposited on the shores of the Wash, and constructed the immense drainage work known as the Carr (Fen) Dyke. They also carried causeways over the fen country. Much of the Roman work seems to have lapsed into the "great dismal swamp," caused by the silting up of the outfalls of rivers, and the mingling of the tides with the upland waters. The submerged territory seems originally to have been rich meadow and forest land, and it receives the river deposits of soil from eight counties, the causes of the great and abiding fertility. All this region then formed an immense estuary, the Wash, or rather a large lake, communicating by shifting channels with the sea. The more elevated grounds were called islands, whose isolation sometimes invited the founders of religious edifices, and sometimes those without the pale of the law. The whole country from Cambridge to Lincoln was a morass abounding with fish and fowl, and all the scattered habitations of the fenmen were liable to be swept away by sudden storms.

The monasteries and the bishops of Ely did good work in the reclamation of lands. Morton's Leam was a canal made by Bishop Morton of forty miles from Peterborough to the sea, which drained the North Level. After the dissolution of the monasteries the work fell into abeyance until renewed by Cornelius Vermuyden. The fenmen vehemently opposed his plans, and Oliver Cromwell, the member for Cambridge, put himself at their head and succeeded in stopping all the operations. When he became protector, however, he sanctioned Vermuyden's plans, and Scotch prisoners taken at Dunbar, and Dutch prisoners taken by Blake in his victory over Van Tromp, were employed as the workers. Much valuable land was reclaimed, and the fen country altogether improved. There remained, however, very much to be done. Vermuyden's system was exclusively Dutch; and while perfectly suited to Holland it did not meet all the necessities of East Anglia. He confined his attention almost exclusively to the inland draining and embankments, and did not provide sufficient out-let for the waters themselves into the sea. So late as 1810 there were districts in which people reaped their harvest, and gathered their orchard fruits, and went to church, in boats. Rennie pointed out the true scientific principle that a thorough drainage could only be effected by cutting down the outfalls to low water at spring tides, and so facilitating the escape of the waters. He projected a great system of drainage and provided a more effectual outfall of the Ouse into the Wash. His work was improved and extended by Telford.

Throughout the present century great improvements of all kinds have been carried on. The surplus waters were formerly pumped into the rivers and canals by *windmills*; but this could not be counted on as an invariable force, and steam-mills are generally substituted. Dykes, causeways, sluices, and drains were now cut in every direction. All the rivers of Cambridgeshire which formerly found their outlet at Wisbeach, before the channel was choked up, now mainly by cuts and straightenings, have forsaken their old beds and are poured into the sea by artificial streams, like the Bedford rivers into the German Ocean.

It will be interesting to enumerate the original courses of the streams; it is not always easy to decipher the natural channels. The chief rivers are the Nene and the Ouse, with its tributary streams. The Nene on arriving at Peterborough turned to the right, and making a circuit of several meres passed by March to Wisbeach. It is now made to flow into three channels. One arm is the Catswater or Shire Drain, which meets Morton Leam and flows into the Wash; the second arm is Whittlesey Dyke, or the old Nene river; the third is Morton's Leam. The Great Ouse enters the Fens near Earith, where it formerly forked; one branch ultimately joined the Nene; the other branch was called the West Water, and ultimately joined the main channel of the Nene. Both the channels are now nearly closed to the waters of the Ouse, and are carried by the Bedford rivers in a direct line to Denver, where they meet the channel of the Little Ouse, and so

reach the sea at King's Lynn. The Cam or Granta, formed by the junction of some small Essex streams, flows N.N.E. from Cambridge, changing its name to Ouse three miles from Ely, but instead of flowing into the sea at Wisbeach is carried on to Denver and thence to the sea at Lynn. The Lark for seven miles separates Cambridgeshire from Suffolk, and the Linnet, a feeder of the Lark, also serves as a boundary stream for another stretch of seven miles.

All the northern part of Cambridgeshire, the fen country, is covered with alluvial deposits resting on a bed of clay of great but unknown thickness. These are called the Kimmeridge and Oxford clays, the Oxford clay lying below the Kimmeridge. There is no break of continuity between them; they are only distinguished by the embodied fossils above the clay. There is a deposit of peat of variable thickness, but generally very deep. South and east the Fens are bordered by a narrow belt of Kimmeridge clay, beyond which is a strip of lower and then of upper greensand; and beyond this, in the southern division of the country, we have the chalk. In the fen country there are great masses of gravel, sand, and drift-clay. "We can trace the rise of the fen lands through the deposits of land-floods, and the growth of fuel-bogs" (Professor Sedgwick). Besides these regular formations and deposits Cambridgeshire contains much diluvial deposit, not to be accounted for by land-floods or tides and currents, but belonging to the glacial period. The uplands or so-called "highlands" of Cambridgeshire are level, but broken by low chalk hills in the neighbourhood of Essex and Suffolk. The chalk is in two divisions,—upper with flints, lower without flints. At the foot of the hills the lower bed of chalk has been extensively quarried, and much elaborate sculpture in Ely Cathedral has been formed of it. The thin upper greensand below the lower chalk rests on gault. This formation everywhere constitutes the northern border of the chalk, and in the western portion of the country forms rich, well-wooded soil. The gault is the blue brick earth of Cambridge, and has a thickness of 150 feet. Professor Sedgwick has given a careful account of the fossils found in these formations, and there is an ample collection of examples in the Woodwardian Museum. In deep diggings in the fen lands, and in excavations for buildings in Cambridge gravel, remains are discovered of the wolf, bear, horse, and *bos primigenius*. Diluvial beds of loam mixed with fragments of chalk extend into the parts of Cambridgeshire adjacent to Essex and Suffolk. Along the irregular line separating Cambridgeshire from these counties the iron-sand which underlies the gault rises to the surface. It forms excellent garden ground, and is rich in fragments of mineralized wood (Conybeare and Phillip's *Geology of England and Wales*). Cambridgeshire is one of the chief corn-producing counties. A part of the county near the south-west border was formerly called the Dairies; and large dairy farms are still found producing cheese very similar to the best Stilton. The census of 1871 returned 25 per cent. of the male population as agricultural labourers, farm-servants, and shepherds. Although the county is entirely agricultural, mainly arable, with some wheat and pasture crops, many busy trades are also carried on,—brewing and malting, brick-making, lime-burning. There is a great deal of boat-building, and there are many seamen employed on the navigable cuts. The climate of the county is generally healthy, but it would be premature to say that ague is altogether banished from the fen country.

Some reference has already been made to the British and Roman antiquities. There are some remains of Roman camps; a few only of Norman castles. In the southern part of the county are four great dykes. They once formed the boundary between East Anglia and Mercia; each extended from fen land to wooded country, crossing the open intervening space. The chief of these fosses was the Devil's Ditch; another was the Fleam or Balsham Dyke; the others were the ditches of Breat and Bran. All these were most probably of British origin. The county of Cambridge is rich in churches, especially in Ely and Cambridge and their neighbourhoods. We have abundant examples of Pre-Norman, Norman, Early English, Decorated, Perpendicular. At Ely there are some valuable monastic remains. The famous Abbey of Thorney is only represented by various foundations, and a fragment of the abbey church, which has been worked into the present parish church. Of domestic architecture there are very slight remains in one or two manor houses, and some remains of the Episcopal palace at Downham. The modern architectural efforts may well compete with those of any former age.

Though Cambridge is the county town, Ely is the one city of Cambridgeshire. It derived its name from the abundance of the eels which were found there. It was situated on the largest of the islands that rose above the level of the Fens, which in winter were surrounded by water, and were only accessible by certain passes or gates. (See ELY.) The other Cambridgeshire towns are soon enumerated. Wisbeach (beach of the Ouse) is a large and prosperous town, next in size and population to Cambridge. The navigable River Nene intersects the town and makes it a port. The main export is grain; the main import is Baltic timber. The Wisbeach canal gives water communication in many directions. Newmarket has a somewhat peculiar reputation, and is called the metropolis of the turf. The race course is four miles in length, of elastic turf; some hundred horses may be seen exercising on the Downs. There are seven race meetings in the year. This and the neighbouring town of Royston, on the borders of Hertfordshire, have been often frequented by royalty; many houses are inhabited by patrons of the turf. Our literature abounds with references to Newmarket, which, truth to say, are as a rule of an unflattering description. Wimpole Park, Lord Hardwicke's place, is the principal seat in the county, and the fine park has some of the best timber in the country. Wimpole is celebrated for its pictures, and there is a good library. The principal other proprietors are the dukes of Bedford and Rutland and Mr Childers. Doddington was till recently the richest living in England, but the revenues are now spread over seven rectories. The village of Babrahan is celebrated as the first place in England where water irrigation was introduced, and also for the breed of Southdown sheep which bears the name. Whittlesea Mere is the most remarkable of the modern reclamation; there abundant crops are raised where boating and fishing were carried on within living memory. Whittlesea West is still covered with water many months in the year, when there is abundance of waterfowl. The ancient town of March should be noticed, also Chatteris, Thorney, Johan, formerly famous for their abbeys. The town of Thorney was greatly improved and beautified by a former duke of Bedford. In 1875 the county was under the ownership of 6497 proprietors of one acre and upwards, and of 6677 proprietors of less than one acre. For parliamentary purposes the two divisions of the shire and isle form one district, returning three members to parliament. The population of the county in 1861, as compared with 1851, exhibited a decrease of 5 per cent., but in 1871 an improvement was manifested to the extent of 6 per cent. The rate of progress is slow, and it is hardly likely to be accelerated. By the census of 1871 the population consisted of 186,906 persons,—of whom 92,115 were males, and 94,791 females. (F. A.)

CAMBRIDGE, the chief town of the above county, and the seat of a famous university, is situated on the Cam, in

the midst of a healthy fertile country, which for the most part has been reclaimed from the fens. The trade of the town is derived from its being the centre of an agricultural district, and from the custom of the resident members of the university. The Cam changes its name to the Ouse as the Isis does to the Thames, and Cambridge is the head of navigation for barges from King's Lynn, which before the railways was connected with a very considerable business. Cambridge is now a chief station on the Great Eastern line, and is also connected with the Great Northern, the London and the North-Western, and the Midland lines. A large market is held on Saturdays. The town has returned two members since the time of Edward I. It is a very ancient corporation, and under the Municipal Reform Act is governed by a mayor, ten aldermen, and thirty common councilmen The university, a corporation separate from

Plan of Cambridge.

the borough, also returns two members. The town has an excellent free grammar school, founded by Dr Perse, good public institutions, and endowed alms-houses. The town owes its existence mainly to the university, which overshadows it in importance. In this respect Cambridge and Oxford differ from all other universities, which are generally absorbed in the town in which they are situated. Cambridge, like Oxford, is of a singularly unique character, and affords examples of architecture from the dawnings of authentic history to the more modern structures designed to meet the wants of our own day. The original Cambridge was the ancient Roman *Camboritum*, a small settlement on the left or north bank of the Cam or Granta. A castle was built to overawe the fen country, of which some ruins may be traced, and Roman coins from the time of Vespasian downwards have been found. In Anglo Saxon times the river was called Granta, and the Roman town Grantchester, a name which still survives in the present village near the town. The modern name was derived from a great stone bridge, the only one in those parts that was thrown across the Cam, probably in old Roman days. Bede gives Cambridge or Grantchester the epithet of "desolate." It was exposed to the assaults of the Danes and repeatedly plundered. In the days of Edward the Elder we find that Grantbridge, a derivation of Cambridge, is giving its name to a shire, in a new division of Mercia. In the 11th century the borough began to expand beyond the narrow Roman limits. A population grew up by degrees on the other side of the river. Religious foundations gradually took their place in the borough. We begin to have authentic annals in the 12th century. Learned men came hither anxious to teach, and scholars anxious to be taught. The students first lived in the houses of the townsfolk, as in German and Scottish universities; we afterwards find hostels, where students and teachers lodged together. It is probable that the great Benedictine monasteries of the Fens may have had a part in the origin of the university. We find Henry III. (1231) issuing writs for the regulation of Cambridge "clerks," and making mention of chancellor and masters. A few years later we find the king entrenching the town with two gates, which, however, were burnt by the barons. In Wat Tyler's insurrection the colleges were attacked and ransacked by the rabble, it was supposed with the connivance and assistance of the Cambridge townsfolk, but were repulsed by the young bishop of Norwich. The first two Stuart kings and the first two Hanoverian kings cultivated friendly personal relations with the university. In the Civil War many of the colleges sent their plate to King Charles, but town and university without actual conflict came into the obedience of the Commonwealth. In other respects Cambridge has been so fortunate as hardly to possess any history.

We proceed to notice somewhat in detail the remarkable structures which have now a European reputation. Although there is no street to equal the glorious High Street of Oxford, yet the long street which begins with the Trumpington Road, and then as a narrow lane fronts Sepulchre Church, is lined with the most important colleges. What is called "the backs of colleges," where the Cam wanders beneath frequent arches through groves and gardens, has a more unique beauty than Oxford or any other university town can display. Within recent years there have been constant changes at Cambridge, and the aspect of the place has been materially altered; there have been great demolitions and reconstructions, and some very fine edifices have been added. The Fitzwilliam Museum, as we first enter Trumpington Street, is a very striking edifice, and as large funds from time to time are accumulated for its extension, it will become increasingly valuable. Recently it has at a great expense received a remarkable amount of colour and decoration. The columned façade, with its portico and colonnades, is considered by some the most striking piece of architecture in the kingdom. It was the foundation of Viscount Fitzwilliam, an Irish peer, who bequeathed to the university his picture gallery, including fine examples of the greatest masters, 120 folio volumes of engravings, a valuable library, and £100,000. Various other valuable collections have from time to time been gathered into the Fitzwilliam Museum. The sculpture gallery is peculiarly rich There are also Colonel Leake's Greek vases, the Disney marbles, the Ellison collection of modern painters, the Mesmer collection. At a short distance from the Fitzwilliam, at the end of a water-course, is Hobson's Conduit, removed here from the market-place, where it stood from 1614 to 1856. Hobson was a great benefactor to Cambridge, and is commemorated by Milton. The Pitt Press is found in this line of street, with a very church-like appearance. It was erected in memory of William Pitt the statesman. Addenbrooke Hospital, the Botanic Garden (arranged after De Candolle's system), the Anatomical Museum, and the Observatory, are very much worthy of examination. The renowned Senate-house, the centre of the university, is remarkable for its elaborate finish and perfect proportions,

In this fine room the university examinations are held and degrees are bestowed. The scenes witnessed here when the mathematical honour list is issued, and on the degree day following, are a very interesting episode of university life. The senior wrangler of the year receives a mighty ovation. Very near the Senate-house is the University Library; the Georges were great benefactors to both. It is one of the few libraries entitled to copies of all new books. The number of books and MSS. is about half a million. The most remarkable MS. is that known to scholars as D, the *Codex Bezæ*, the uncial MS. or vellum of the four Gospels and the Acts, presented by Theodore Beza. The front of the library is an Italian balustraded arcade; the basement story of the quadrangle is called "the Schools," a much more limited expression than the same Oxford term. In the "school" were once carried on the lectures and disputations from which "wranglers" and "sophs" derived their names. One part of the schools is devoted to the Woodwardian or Geological Museum, enriched by the collections of the late Professor Sedgwick. He taught geology to undergraduates in visiting the neighbourhood with them. Close to this is the Mineralogical Museum, enriched with diamonds presented by the late Lord Alford. The fine new buildings of the Union Society are noticeable. Various Cambridge churches are very interesting. The Round Church or Sepulchre Church is one of four similar churches in England (the Temple Church being one), modelled after the Church of the Holy Sepulchre at Jerusalem. It was restored in 1841 by the Camden Society. Great St Mary's, like St Mary's, Oxford, is the church of the university. St Benedict (or Benet) Church is very interesting. Its restoration in 1869 fully displayed the magnificent Romanesque arch of great antiquity, and traces of Early English and Pre-Norman remains. St Mary's the Less, next to Peterhouse, is a very ancient church. The old church of All Saints, opposite St John's, has been removed, and is rebuilt in Jesus Lane. There are a large number of modern churches. There is a wide market-place and several open spaces, such as Christ's Piece and Parker's Piece. The railway station, where different companies find a common home, is spacious and handsome. The so-called school of Pythagoras (the origin of the term is obscure) was doubtless the abode of a Thegn or Saxon gentleman. The mound of the Castle, a natural hill scarped and cut down, must have been of great importance in overlooking the fen country. It was probably within the lines of the Roman station, and a castle was built here by the Conqueror; many houses, according to *Domesday Book*, being removed to make way for it. Edward I. lodged here, but the castle was soon in ruins. The massive gateway was removed to make way for the county courts. The county gaol, at the rear of the county court, was arranged according to plans of John Howard the philanthropist.

Each college in Cambridge has its separate interest,—something remarkable in chapel, hall, or library, in garden or gallery. We shall rapidly indicate some distinctive features in each. The largest of the colleges is Trinity, the largest collegiate foundation in Europe. It is on both sides the street, for a new court, the Master's Court, was built at the expense of Dr Whewell, and his cipher, W.W., is on the capacious tower. The King's Gateway is the entrance to this famous college. The great canopied statue is that of Henry VIII., in whose time this vast portal was built by the scholars of Trinity. We pass into the great court with its velvet sward and the lofty stone conduit, known as Nevill's Fountain. On one side is the Master's Lodge, with a fine collection of portraits, and a set of state rooms. On the same side is the lofty Gothic hall, with a high-peaked Flemish roof. In term time when the great hall, with its painted glass and armorial bearings, is crowded with students, the sight is remarkable enough. On entering the chapel the ante-chapel should be carefully noted, with the statue of Newton in a sitting posture, the statue of Barrow, a statue of Macaulay, and soon there will be one of Whewell. A second great gateway, with the niched statue of Edward III., leads into the second court. On the south is a third gateway with four towers on the angles, called, from a statue of Queen Elizabeth in her robes, the Queen's Gateway. The library was begun by Barrow and designed by Wren. It is the most classic building in the university—in Wren's favourite style of the old Italian. It overlooks the river, and below the library is a colonnade opening on the bridge and the Lime Walk. In the value of its contents this library ranks next to the university library; it possesses the mathematical MSS. of Newton and the poetical MSS. of Milton. It numbers nearly 100,000 volumes. The woodwork is by Gibbons; the series of marble busts by Roubillac. Recent additions have been made of the busts of Professor Sedgwick, Mr Tennyson, and Mr Ellis. At the end of the room is Thorwaldsen's statue of Lord Byron, which was refused admission into Westminster Abbey.

St John's.

The next largest college is St John's, which is famous for its series of splendid improvements. The college consists of four courts; the plain brick edifices are carried to the brink of the river, but on the other side of the river is the magnificent New Court designed by Rickman, the finest modern structure of all the Cambridge quadrangles. The massive antique gateway of the first court has the armorial bearings of the foundress of this college and Christ's College, the Lady Margaret, countess of Richmond and mother of Henry VII. The chapel and hall are in the front court. The second court is still larger, and is one of the very few untouched by modern restoration. The third court has a cloister on the west; and the antique library, unaltered for generations, takes up the whole upper part of the north side. The Master's Lodge, finished in 1865 by Sir G. G. Scott, extends westward. A light Gothic bridge over the Cam conducts into the New Court, a stately quadrangle, with a vaulted cloister along the south side. The magnificent chapel, erected mainly by the society, and enriched with many gifts, at great expense, was opened in 1869. It was erected by Sir G. G. Scott, and has some resemblance to the Sainte Chapelle at Paris. The roof and painted glass are especially remarkable. Chantrey's monument to Henry Kirke-White, erected at the expense of an American gentleman, is to be transferred to this chapel.

St Peter's.

St Peter's College, or Peterhouse, is the oldest of the colleges. It was founded in 1257 by Hugh de Balsham, who was one of the first to separate between the monkish and scholastic element in education. The university long gave special honour and celebration to De Balsham. St Peter's is remarkable for eminent men, and for lay fellowships at a time when they were hardly known elsewhere. The gardens are good, and there is a small deer park.

King's.

King's College owns that magnificent chapel which widely dominates over all the buildings in the town and university. The college was originally commenced and endowed by Henry VI., in connection with Eton. Henry VII. deserves the title of a second founder. The chapel is one vast long-drawn nave. It is the latest and most sumptuous example of the Perpendicular order of Gothic architecture. The fretted roof, unsustained by a single pillar, is vaulted into twelve divisions. The centre of each is a pendant keystone, terminating alternately in roses and portcullises, each keystone weighing more than a ton. Over the stone roof is the timber roof. An organ separates between chapel and ante-chapel. The painted glass is the most remarkable that has been bequeathed to us by the age of Henry VII. and Henry VIII., and belongs to a time when the art of

painting had attained its highest excellence. There are five-and-twenty windows, with more than a hundred subjects. The chantries are fine. The exterior of the chapel, though very fine, hardly corresponds with the interior. The immense design for the college, entertained by Henry VI., has never been carried out, and the new buildings, erected at a great expense, have not been subordinated to the general design. The best of these is the Master's Lodge; the Fellows' Buildings are incongruous. King's College Chapel is certainly the architectural gem of the university.

Caius (pronounced Key's) College, in point of size, is the third college in the university. It has a somewhat special character, being termed the Medical College. The founder was a physician high in favour with Philip and Mary. His tomb, with the inscription "Fui Caius," is the great ornament of the chapel. In the painted glass of the chapel is a series delineating the miracles of healing. No college has undergone greater alterations within recent years than Caius College, the larger part of the college having been taken down and rebuilt. It has now some of the most striking architectural effects in modern Cambridge. The three famous gates—the Gate of Humility, the Gate of Virtue, the Gate of Honour—are retained. Mr Fergusson says of the last "that it is one of the most pleasing as well as one of the most advanced specimens of the Early Renaissance in England." The new hall is by Salvin (1864). The little college of Trinity Hall has also a special character, being the Legal College. To a great extent it has been rebuilt, after a destructive fire in 1851. The gardens are very fine.

Queens' College is the work of the two rival queens of the Red Rose and the White, Margaret of Anjou and Elizabeth Woodville, who are always regarded as co-foundresses. Erasmus took up his abode here and promoted the new learning. His study is supposed to have been in the south-west tower of the old court. The chapel has been beautifully restored in recent years. A quaint bridge, called the "mathematical bridge," leads into the garden or wilderness on the other side of the Cam. On the south side of the Cloister Court is Erasmus's Court. It is said to be in contemplation to fill up the western side with a new river front. Corpus Christi College has an imposing frontage, not unlike that of Christ Church, Oxford, though on a smaller scale. This college has the credit of having begun the series of reconstructions which has been in progress for years past up to the present time. The college is in intimate relations with the town of Cambridge, in which it has much property, and from which it has derived various benefactions. On the north end of the great quadrangle is the Old Court, which is said to retain more of its original features than any other court in the university. Archbishop Parker lent his library to this college on condition that if twenty-five books should ever be missing the bequest should devolve to Caius College. Opposite Corpus Christi is the college long known as Catherine's Hall, the only hall in Cambridge, but in the unfulfilled expectation of many private halls being established now termed a college. It is extremely picturesque, with a side of the principal quadrangle planted with elms and open to Trumpington Street. It might almost be called the Theological College, as it has produced an extraordinary number of ecclesiastical writers. Clare College consists of a single court, and is remarkable for its finished beauty, with "more purity and grace than any other example which can be named" (Fergusson). The bridge, avenue, and lawn are noticeable. This college is supposed to be Chaucer's "Soler Hall at Cantabrage." Once one of the largest, it is now one of the smallest colleges. Here "Ignoramus" was acted before the delighted James I.

Emmanuel College has a peculiar interest of its own. Once its site was occupied by a house of Dominican friars, and it subsequently became the chosen college of the Puritans. The frontage of this college is long and imposing. Through an arcade we pass into the principal court, above an arcaded side of which is a picture gallery designed by Wren for the Master's Lodge. The library here is very good. Sidney Sussex College has a history very parallel to that of Emmanuel College. They were together styled in the time of Charles I. "nurseries of Puritanism." Oliver Cromwell was a member of this college, and the best extant likeness of him is to be found here. There is also *Bernini's* bust from the plaster impression taken after death. This college was improved to the extent of entire obliteration by Wyatville, who has only left the old oriels of the Master's Lodge remaining. The lodge has a large pleasure garden attached. Next to this college is Christ's, opposite to which a street runs westward that has some curious old houses and an old name, Petty Cury, the meaning of which has been much discussed; it most probably means "little cookery." Christ's College was the foundation of the Lady Margaret, the saintly foundress of St John's. Her portrait is in chapel and hall, and her arms over the gateway. Like Sidney Sussex, Christ's was restored in the last century, and nearly all traces of antiquity extinguished. Christ's is famous for its associations with the Platonists, and especially with Milton. His rooms are pointed out, and his mulberry tree in the garden has drawn pilgrims from every part of the world. The old tree is carefully propped up and mounded, and a new tree has been planted from an offshoot. Behind the college is an open space of park-like character leading down to the boats. Some of the latest restorations now in progress are in Pembroke. When Queen Elizabeth saw this college she exclaimed, "Oh domus antiqua et religiosa!" but the peculiar features which give this college its picturesque appearance are being inexorably sacrificed to modern requirements. The chapel was designed by Sir Christopher Wren, and executed at the cost of his uncle, Bishop Wren, as a thank-offering for his liberation from a confinement of eighteen years in the Tower. The college has been called "Collegium Episcopale," from the number of its prelates. It also boasts the great names of Edmund Spenser, Gray, and William Pitt. Jesus College stands pleasantly back from the public road, surrounded with gardens and meadows. The ivied walls have a very pleasant aspect. The college chapel is a very noble one, and may rank after King's College chapel and the new chapel of St John's. It is among the most magnificent of the recent restorations at Cambridge. It is part of the old church of St Rhadegund; the ante-chapel, which is being decorated under the care of Mr Rossetti, being portion of the original nave. The New Court or Garden Court is shadowed with trees of many years' growth. The college has recently laid out fresh grounds and buildings. The cock, the badge or *rebus* of Bishop Alcock, the founder, is discernible in many parts of the college. Magdalene College is the only college on the north side of the Cam. It was founded by a lord of Audley End, whose representative always nominates the head of the college. It boasts three libraries,—the college library, the Peckard library, and the Pepysian library. The last contains the Pepy's MS. and much old black-letter literature. The last of the Cambridge colleges is Downing College. It was only founded in the year 1800, with large bequests from a Cambridgeshire baronet. The first undergraduate was in 1821, but the college has in later years received a considerable development. The well-wooded grounds are handsome and extensive, and are thrown freely open to the public.

Some of the Cambridge localities should be mentioned. The suburb of Barnwell has the remains of an ancient

priory. At Stourbridge is the disused chapel of an ancient hospital for lepers. The greatest fair in England was one held here. The little village of Trumpington is a favourite locality. Granchester has some remains which make it a question whether it or Cambridge Castle was the site of the old Roman station. Byron's Pool is in the river here. Madingley is a fine old mansion, the residence of the Prince of Wales when at Cambridge, and possibly the scene of Gray's *Elegy*. Between this place and Cambridge is the Observatory. The central dome revolves on wheels, and can be moved by a single hand. The remarkable telescope was presented by the late duke of Northumberland in 1835. A favourite walk is to the very moderate elevation known as the Gogmagog Hills, an off-shoot of the chalk range, the summit of which has been a Roman camp and a lord-treasurer's abode. The Ladies' College at Girton may also be mentioned. Chesterton and Cherry Hinton are familiar resorts of Cambridge men. These are environs of Cambridge. The borough population of Cambridge in 1871 was 30,078, consisting of 13,742 males and 16,286 females. (F. A.)

CAMBRIDGE, a city of the United States, in the county of Middlesex, Massachusetts. It lies on Charles River, three miles N.W. of Boston, with which it is connected by two bridges, with long causeways, and by horse railroads, or tramways It is the seat of Harvard University, the oldest, richest, and most thoroughly equipped literary institution in the United States. Connected with the university is an observatory, in 42° 22′ 48″ N. lat. and 71° 8′ W. long. Under the name of Newtown a settlement was made on its territory, then much more extended than at present, by some of the first company of English colonists on Massachusetts Bay in 1630. It was then proposed to make it the capital of the colony; but the neighbouring peninsula of Boston was found more convenient for commerce and defence against the Indians. The order of the colony court in 1636 having provided for planting a college at Newtown, its name was changed to Cambridge, in honour of the English university town, where some of the leading men of the colony had been educated. The first company of settlers, being Mr Hooker's church and congregation, moved to Connecticut in 1636, to find better farm-land. Their rights were purchased by another body of colonists just arrived from England. The present site of the college halls was originally "fortified" by palisades, within which the settlers found protection at night for themselves and their cattle against a possible inroad of the savages. Here was set up the first printing-press in the United States, and from it issued John Eliot's translation of the Bible, for the Indians, in their own language. Under the title of "Cambridge Farms," the present town of Lexington, incorporated as such in 1712, was a part of the original town. The town of Brighton, now annexed to the city of Boston, formerly South Cambridge, or Little Cambridge, was separated and received its present name in 1807; and the west part of the original settlement, known as Menotomy, was marked off in the same year, as West Cambridge, now known as Arlington. Between this place and Cambridge is North Cambridge; and the districts of the city nearest to Boston, by the two bridges, are called Cambridge Port and East Cambridge. Cambridge was incorporated as a city in 1846. It is for the most part level, with much marsh land near the river, portions of which are in process of being reclaimed. The cemetery of Mount Auburn is on the western border of the city. The population of Cambridge in 1874 was 50,337; the numbers of polls for voters, 11,983; of dwellings, 7383. The valuation was—of personal property, $17,532,971; of real, $49,013,700; total, $66,576,671. The net debt of the city incurred for water-works, streets, school-houses and other improvements, is $3,792,135. The city appropriation for 1874 was $2,771,508. Total cost of the water-works, $1,399,396. The police department, with 60 officers, cost $71,710; fire department, $97,355; filling up low lands, $650,000. The average number of paupers, 129; net cost of their maintenance, $38,000. Cost of street lighting, $20,157. The system of public schools is very complete and efficient, including a high school, 7 grammar schools, 18 primaries, and a training school,—with 183 teachers; cost of maintenance, $260,187·47. Cambridge was the site of the camp of the first American army, at the outbreak of the War of the Revolution with Great Britain. From it went the detachment which intrenched on Bunker's Hill; and here Washington took command of the army, July 3, 1775.

CAMBYSES, a Persian royal name, derived from the Greek Καμβύσης, in which form it appears in Herodotus and in the Greek writers generally. In inscriptions from Egypt the name is given as Καμβύσαις (Letronne, *Recueil d. inscrip. grecq.*, ii. pp. 350, 356, *f.*). In the old-Persian of the Behistun inscription it stands in the form *Kabujiya* (Rawlinson) or *Kambujiya* (Oppert, Spiegel). In Zend the name takes the form *Kavaus*, and in Arabic and modern Persian it is worn down still further to *Kavus* and *Kaus*. In Egyptian the name occurs under three forms of transcription,—*Kanbuza*, *Kembatet* (Lepsius, *Königsbuch*, taf. xlix.), or rather *Kambuzia*, and *Kambunsa* (Lauth, *Ein neuer Kambyses-text*, p. 5). The etymology of the name is obscure, and the attempts to explain it by Rawlinson (*Jour. As. Soc.*, xi. p. 97) and Benfey (*Die persischen Keilinschriften*, p. 77) cannot be regarded as successful. It has been often remarked that the name, or one very similar, occurs more than once in the East as an ethnical and geographical designation. Thus we find Camboja a territory in India, Kamoj a tribe of the Kafirs in Cabul; and a territory named Cambysene, situated in the north on the Kur, is known to Greek geographers. In the same region there was a river called Cambyses, the modern Jora. Perhaps with Spiegel (*Eranische Alterthumskunde*, vol. ii. p. 294) we may regard the personal name Kambujiya as originally an adjective, meaning belonging to Kambuja. In Egypt, also, Cambysu occurs in the *Itinerarium* as the name of a place in the Delta, but this is probably derived from the Persian king about to be mentioned, by whom Egypt was conquered

The persons known by the name of Cambyses belong to the Achæmenian line of Persian kings. It is thought that the great-grandfather of Cyrus the Great was thus called. The evidence, however, for the existence of this Cambyses, though strong, is constructive rather than direct (see Rawlinson's *Herodotus*, vol. iv. p. 259). It is certain that the father of Cyrus was named Cambyses. He is called by Herodotus (i. 107) "a Persian of good family," but by Xenophon (*Cyrop.*, i. 11, 1) he is denominated "king of the Persians." The justness of this title is proved by an inscription on a brick found at Senkereh, in which Cyrus calls himself "the son of Cambyses, the powerful king," as well as by the statement of Darius Hystaspis, in the Behistun inscription (col. i. 4), that eight of his Achæmenian ancestors had been kings. During the reign of this Cambyses the Persian nation was included in the Median empire, and he is represented as the vassal of the Median king Astyages. At the same time he is said to have married Mandane, the daughter of Astyages, by whom he became the father of Cyrus. Such, at least, is the account of Herodotus, Xenophon, Diodorus, and Trogus Pompeius. Ctesias and Nicolaus Damascenus give a different representation.

It is stated by Loftus (*Chaldæa and Susiana*, p. 224) that he found at Warka "bricks inscribed in slightly

relieved cuneiform characters of Cambyses, the brother of Cyrus, a personage of whom we possess no historical notice whatsoever."

The only other, and the best known, king of this name is the elder son and successor of Cyrus, who reigned over the Persian empire, according to Herodotus, for seven years and five months—from 529 to 521 B.C. Of his proceedings before his famous invasion of Egypt little is known. To this period we must now, on the authority of the Behistun inscription (i. 10), in opposition to Herodotus (iii. 30), assign the secret murder of his brother, Bardiya (the Smerdis, Merdis, Mardus, or Mergis of the Greeks,—called Tanyoxarces by Ctesias, and Tanyoxares by Xenophon). Egypt at this time lay on the borders of the Persian empire; its subjugation had long been an object of ambition to the great Asiatic conquerors; it had recently provoked reprisals from Persia by sending help to Lydia against Cyrus; and in resolving to attack that country Cambyses was both carrying out the settled policy of his predecessors and accomplishing the purpose of his own father. If therefore, as is not unlikely, there was such an occasion given for the enterprise as that which Herodotus relates, it is not necessary to suppose that this was more than a pretext. A year or two were spent in collecting the forces of the empire, and the preparatory measures taken seem to have been marked by prudence and skill. A fleet of Phœnician and Greek ships was collected to operate against the vessels of the Egyptians; and the help of an Arabian chief was secured to provide water for the army in crossing the desert on the south and west of Palestine. The old king of Egypt, Amasis, under whom the country had enjoyed a long period of peace and prosperity, died a few months before the invasion, and was succeeded by his son Psammenitus, under whom the measures of defence proved unsuccessful. An obstinately contested but decisive victory was gained by the Persian arms near Pelusium, and this was speedily followed up by the siege and capture of the capital, Memphis, and by the subjugation of the whole country. The date of this conquest is commonly regarded as 525 B.C. (see Rawlinson, *Anc. Mon.*, vol. i. p. 385), though some find cause to place it one or even two years earlier (*cf.* v. Gumpach, *Zeitrechnung d. Ass. u. Bab.*, pp. 165, *f.*; Lauth, *op. cit.*, pp. 13, *f.*; Brugsch, *Hist. d'Égypte*, i. p. 267; Duncker, *Gesch. d. Alterthums*, vol. ii. p. 792, *n.*; Lepsius, *Königsbuch*, p. 89).

Henceforward the life and activity of Cambyses centred in his new dominion. We know from an important hieroglyphic inscription proceeding from a priest of Neith at Sais, that he assumed the responsibilities and titles proper to a king of Egypt, taking as his throne-name that of Ramesut. Moreover, it is evident that for a time at least he cultivated the good-will of his new subjects. We learn that he took Egyptians who had been officers of Psammenitus into his immediate service; that he sought instruction in regard to the rites of their religion, and was initiated into certain of its mysteries; that he listened to complaints in regard to the profanation of the temples by Persian and other foreign soldiers, and gave orders for their removal from the sacred precincts; that he secured the priests in the receipt of the temple-revenues, and arranged for the due and continued celebration of the customary ceremonies and festivals. A monument is still extant on which he is represented adoring, on bended knee, the god Apis. (See De Rougé, *Mémoire sur la statue naophore du Vatican*, passim: Brugsch, *op. cit.*, vol. i. pp. 266, *f.*; Lauth, *op. cit.*, pp. 17, *f.*) One act, indeed, of a different complexion is reported by Herodotus (iii. 16), viz., his outraging and finally consuming by fire the embalmed body of Amasis,—an act, the historian assures us, which shocked the feelings alike of Egyptians and of Persians, and which strongly attests the same jealous and resentful temper which prompted the murder of his brother.

After having established himself in his new possession, Cambyses, Herodotus (iii. 17, *f.*) informs us, planned three expeditions. One was against Carthage, in regard to which, however, he was thwarted by the refusal of his Phœnician mariners, who formed the principal portion of his sea-forces, to operate against their kindred. Another was directed against the Oasis and temple of Jupiter Ammon in the desert west of Egypt (see Heeren, *D. afrikan. Völker*, i. p. 416), the issue of which was that the whole of the force sent on this enterprise, numbering, it is said, 50,000 men, perished in the sand. The third was intended for the subjugation of the Ethiopians on the south of Egypt (regarding whose locality see Heeren, *op. cit.*, i. pp. 337, *f.*; Rawlinson, *Herod.*, vol. ii. p. 421; Maspero, *Histoire ancienne*, pp. 533, *f.*), and of this Cambyses himself took the command. The army, however, had marched less than a fifth of the distance when their provisions failed, and they were reduced to the utmost straits,—even, it is said, to cannibalism. Cambyses was thus forced to retrace his steps and to lead back the remnant of his army to Egypt in disappointment and disgrace.

Under the smart of this threefold discomfiture the conduct of Cambyses towards the Egyptians assumed a new and much more stern and cruel aspect. The people of Memphis were rejoicing on occasion of the discovery of a calf bearing the marks of their god Apis, when he arrived there on his return from his unfortunate expedition. Irritated by their apparent lack of sympathy, and misconstruing their joy, he ordered some of the magistrates of the city to be put to death; and what was still more fatal to his popularity, he commanded the newly-found god to be led into his presence, and inflicted upon it with his dagger a mortal wound. The epitaph of this unfortunate god "has been found by M. Mariette in the Serapeum, and is now in the museum of the Louvre" (Lenormant, *Manual of Anc. Hist.*, vol. ii. p. 99). We hear also of his violating the sepulchres of the Egyptians, and of his penetrating into the sanctuaries of their gods, and making sport of the more grotesque images. According to Herodotus, it seemed to the Egyptians that he had gone mad; and it is certain that they retained the most gloomy recollections of this period of their history. In the inscription already mentioned, drawn up while the Persians were still supreme in the country, and therefore with due reserve and caution, reference is made to the procedure of Cambyses in such language as the following:—"There happened a calamity in this district along with the very great calamity which befell the whole land;" "a frightful misfortune befell Egypt, the like of which never occurred in this land" (Brugsch, *op. cit.*, i. p. 271; Lauth, *op. cit.*, p. 19, *cf.* p. 49). It is, in all probability, the sense of this "frightful misfortune"—the keenness of feeling excited by the outrageous deeds of Cambyses towards their gods—which led the Egyptians to allege that he was smitten with frenzy, and to put in circulation some at least of the many stories relating to his cruelty towards his own countrymen and relatives which Herodotus and others report.

After an absence from Persia of several years, Cambyses, having appointed Aryandes, a Persian, governor of Egypt, set out on his homeward march. He was met, according to Herodotus (iii. 64), at a place in Syria called Agbatana, supposed by some to be Batanaea or Bashan, by others to be Hamath, by the tidings of the Median revolution, the usurpation of the sovereignty by Gomates, the Magian, and the impersonation by the usurper of his own brother whom, as has been noticed, he had caused to be secretly murdered. Springing hastily upon his horse, his sword fell from the sheath and wounded him mortally in the thigh. According

to Ctesias (*Exc. Pers.*, § 12) he died at Babylon, of a wound accidentally inflicted while carving a piece of wood for his amusement These accounts agree in representing his death as accidental A somewhat different impression is conveyed by the statement of Darius on the point in the Behistun inscription (i. 11), who says that "killing himself he died' (*Cf.* Oppert, *Les inscriptions des Achéménides*, p. 54.) It may be, as Spiegel believes (*Eran. Alterthum.*, ii. p. 302), that the phrase expresses nothing more than the Greek tradition reports. Rawlinson, however (*Anc. Mon.*, iv. p. 394), and Duncker (*op. cit.*, ii. p. 801) understand it as meaning that he committed suicide. The character of this king is sufficiently obvious. It is evident that he was an impulsive, self-willed, reckless, ambitious despot, of the peculiarly Oriental type, possessed of considerable ability as a general, but with passions so strong and uncontrolled as to render the powers he possessed worthless for good. It was reported that from his childhood he was liable to epilepsy and also, what is probably more trustworthy, that he came to be much given to wine. By the Egyptians he made himself utterly abhorred. By the Persians also, while they acknowledged his success in enlarging their empire, his memory was held in evil repute. While they called Cyrus a father, they called his son a despot or master; and while they said the one was "gentle, and procured them all manner of goods," they called the other "harsh and reckless" (see Herodotus, iii. 33, 34, 89). In the Hebrew Scriptures, Cambyses appears once under the name of Ahasuerus, in Ezra iv. 6 (see ARTAXERXES). Some suppose that he is the "cruel lord" and "fierce king," to whose hands the Egyptians were to be given over, according to Isa. xix. 4 His name occurs in Babylonian contract-tablets found at Warka, with the title "Cambyses, king of Babylon." (See Loftus, *op. cit.*, p. 222; Bosanquet, *Trans. Bib. Archæology*, i. pp. 210, *f.*) He is usually regarded as the Lohrasp of Persian traditional history (Malcom, *Hist. of Persia*, i. p. 334); but another of the heroes of that cycle of romance, Kaus, appears both from the name and from the exploits ascribed to him to be the true representative of Cambyses. (*Cf.* Spiegel, *op. cit.*, vol. i. p. 594; Gobineau, *Hist. des Perses*, vol. i. p. 523.) (W. TU.)

CAMDEN (1), a city of the United States, capital of Camden county, New Jersey, situated on the left bank of the Delaware River, directly opposite Philadelphia, with which it is connected by a regular steam-boat service. It lies 87 miles S.W. of New York, and is the terminus of several railway lines. Among its public buildings the chief place is held by the court-house and the railway stations; and its principal industrial establishments are iron-foundries, saw-mills, chemical works, glass-works, shipyards, and engineering factories. The city received its charter in 1831; and gas-light was first introduced in 1852. In 1840 the population was only 3371; in 1850 it amounted to 9479, and in 1870 to 20,045.

CAMDEN (2), the capital of Kershaw county in South Carolina, United States, 33 miles N.E. of Columbia on the Wateree River, which is navigable for steam-boats as far as the town. It contains an arsenal, an academy, and a library, and is altogether a flourishing little town. It is best known as the scene of two battles,—the first fought in 1780 between Gates and Cornwallis, and the second in 1781 between Greene and Rawdon. Population in 1870, 1007.

CAMDEN, WILLIAM (1551–1623), a celebrated antiquary and historian, was born in London, May 2, 1551. His father, who was a native of Lichfield, settled in London, where he became a member of the company of paper-stainers. His mother was of the ancient family of Curwen of Workington in Cumberland. Young Camden received his early education at Christ's Hospital and St Paul's School; and in 1566 he entered as a servitor of Magdalen College, Oxford; but not succeeding in getting a demi's place, he removed to Broadgate Hall, and, somewhat more than two years afterwards, to Christ Church, where he was supported by his friend and patron Dr Thornton. About this time he became a candidate for a fellowship at All Souls College, which he lost through the adverse influence of the Roman Catholic party. In 1570 he supplicated the regents of the university to be admitted bachelor of arts, but in this also he was disappointed. The following year Camden came to London, where he prosecuted his favourite study of antiquity, under the patronage of Dr Goodman, dean of Westminster, by whose interest he was made, in 1575, second master of Westminster school. From the time of his leaving the university to this period, he had travelled through great part of England, with a view to make observations and collect materials for his *Britannia*, on which he was now seriously engaged. In 1581 he became intimately acquainted with the learned President Brisson, who was then in England, and in 1586 he published the first edition of the *Britannia*, a survey of the British isles, written in elegant Latin. In 1593 he succeeded to the head mastership of Westminster school, on the resignation of Dr Grant. In this office he continued till 1597, when he was promoted to be Clarencieux king-at-arms. In 1600 Camden made a tour to the north, as far as Carlisle, accompanied by his friend Mr (afterwards Sir Robert) Cotton. In 1606 he began his correspondence with the celebrated President de Thou, which continued to the death of that historian. In the following year he published his last edition of the *Britannia*, from which the several English translations have been made; and in 1608 he began to digest his materials for a history of the reign of Queen Elizabeth. In 1609, after recovering from a dangerous illness, he retired to Chiselhurst in Kent, where he continued to spend the summer months during the remainder of his life. The first part of his annals of the queen did not appear till 1615, and he determined that the second volume should not appear till after his death. The work was entirely finished in 1617, and from that time he was principally employed in collecting materials for the further improvement of his *Britannia*. In 1622, being now upwards of seventy, he determined to lose no time in executing his design of founding a history lecture in the university of Oxford. His deed of gift was accordingly transmitted by his friend Mr Heather to Mr Gregory Wheare, who was by himself appointed the first professor. Camden died at Chiselhurst, Nov. 9, 1623, in the seventy-third year of his age, and was buried with great solemnity in Westminster Abbey, where a monument was erected to his memory. He was a man of great modesty and integrity, profoundly learned in the history and antiquities of England, and a judicious and conscientious historian. The Camden Society, founded in 1838 for historical research, was so named in honour of him. Besides the works already mentioned, he was author of an excellent Greek grammar, and of several tracts in Hearne's collection. His greatest and most useful work is the *Britannia*. It was first translated into English, and published in folio in London in 1611, by Dr Philemon Holland, who is thought to have consulted the author himself; and therefore great respect has been paid to his additions and explanations, on the supposition that they may belong to Camden. But in a later edition of the same translation, published in 1636, the doctor has taken liberties which cannot be excused. A new translation, made with the utmost fidelity from the last edition, was published in 1695, by Edmund Gibson of Queen's College, Oxford, afterwards bishop of London; in which, besides the addition of notes, and of all that deserved to be taken notice of in Dr Holland's first edition, there are many other augmentations

and improvements, all properly distinguished from the genuine work of the author.

Gibson's edition was reprinted in 1722, and several times subsequently. The latest and best editions are those by Gough, 1789-90, 3 vols. fol., and by Gough and Nichols, 1806, 4 vols. fol.

CAMDEN, CHARLES PRATT, EARL, AND VISCOUNT BAYHAM (1713-1794), chief-justice of the Common Pleas, lord chancellor of England, and president of the council, was born in 1713. He was a descendant of an old Devonshire family of high standing, the third son of Sir John Pratt, chief-justice of the King's Bench in the reign of George I. He received his early education at Eton College, whence he passed, at the age of seventeen, to King's College, Cambridge. In 1734 he became a fellow of his college, and in the following year obtained his degree of B.A. Having adopted his father's profession, he had entered the Middle Temple in 1728, and ten years later he was called to the bar. He practised at first in the courts of Common Law, travelling also the western circuit. In 1740 he took his degree of M.A. For some years his practice was so limited, and he became so much discouraged, that he seriously thought of turning his back on the law and entering the church. He listened, however, to the advice of his friend Sir Robert Henley, a brother barrister, afterwards known as Lord Chancellor Northington, and persevered, working on and waiting for the success which in such case is usually slow to come. The first case which brought him prominently into notice and gave him assurance of ultimate success was the Government prosecution, in 1752, of a bookseller, William Owen, for a libel on the House of Commons. Pratt was engaged as junior counsel for the defence, and he made his mark in an earnest and powerful speech, which contributed to the verdict for the defendant. In 1753 he undertook the defence of Murphy, who stood charged with the forgery of a will. Four years later, through the influence of William Pitt (afterwards earl of Chatham), with whom he had formed an intimate friendship while at Eton, he received the appointment of attorney-general. The same year he entered the House of Commons as member for the small borough of Downton in Wiltshire, which was subsequently disfranchised. He sat in parliament four years, but did not distinguish himself as a debater. His professional practice now largely increased. One of the most noticeable incidents of his tenure of office as attorney-general was the prosecution of Dr Shebbeare, a violent party writer of the day, for a libel against the Government contained in his notorious *Letters to the People of England*, which were published in the years 1756-1758. As a proof of Pratt's moderation in a period of passionate party warfare and frequent "State Trials," it is noted that this was the only official prosecution for libel which he set on foot. In January 1762 Pratt was raised to the bench as chief-justice of the Common Pleas, this post being vacant by the death of Chief-Justice Willes. He was at the same time knighted. Soon after his elevation the nation was thrown into great excitement about the prosecution of the "worthless profligate" John Wilkes, and the question involved in it of the legality of "general warrants." Chief-Justice Pratt pronounced, with decisive and almost passionate energy, against their legality, thus giving voice to the strong feeling of the nation, and winning for himself an extraordinary degree of popularity as one of the "maintainers of English constitutional liberty." Honours fell thick upon him in the form of addresses from the city of London and many large towns, and of presentations of freedom from various corporate bodies. In July 1765 he was raised to the peerage as Baron Camden, of Camden Place, in the county of Kent; and in the following year he was removed from the court of Common Pleas to take his seat as lord chancellor (July 30, 1766). This seat he retained less than four years; for although he discharged its duties in so efficient a manner that, with one exception, his decisions were never reversed on appeal, he took up a position of such uncompromising hostility to the Governments of the day, the Grafton and North administrations, on the greatest and most exciting matters, the treatment of the American colonies and the proceedings against John Wilkes, that the Government had no choice but to require of him the surrender of the great seal. He retired from the Court of Chancery in January 1770, but he continued to take a warm interest in the political affairs and discussions of the time. In his speeches in the House of Lords he sometimes showed a strong ill-feeling against his great opponent, Lord Mansfield, on the doctrine of libel. He continued steadfastly to oppose the taxation of the American colonists, and signed, in 1778, the protest of the Lords in favour of an address to the king on the subject of the manifesto of the American commissioners. In 1782 he was appointed president of the council under the Rockingham administration, but retired in the following year. Within a few months he was reinstated in this office under the Pitt administration, and held it till his death. Lord Camden was a strenuous opponent of Mr Fox's India Bill, took an animated part in the debates on important public matters till within two years of his death, introduced in 1786 the scheme of a regency on occasion of the king's insanity, and to the last zealously defended his early views on the functions of juries, especially of their right to decide on all questions of libel. He was raised to the dignity of an earl in May 1786, and was at the same time created Viscount Bayham. Earl Camden died in London, April 18, 1794. His remains were interred in Seale church in Kent.

CAMEL, the *Djemal* of the Arabs and *Gamal* of the Hebrews, a genus of Ruminant Mammals, which, with the South American llamas, form the family *Camelidæ*, and which in their dentition, in the absence of horns and of hoofs completely enveloping the toes, and in the separation of the navicular and cuboid bones of the tarsus, show an affinity with certain of the Perissodactyle *Ungulata*. In common with the llamas, and unlike all other ruminants, the camel has two upper incisor teeth, conical and laterally compressed, and somewhat resembling canine teeth, of which in the upper jaw there are two, in addition to twelve molars. Beneath there are six incisors, two canines, and ten molar teeth, the whole forming a dentition admirably suited for the tearing asunder and mastication of the coarse dry shrubs on which the camel usually feeds. It possesses besides many other peculiarities in form and structure specially adapted to its mode of life. Its nostrils are in the form of oblique slits, which can be opened or shut at will, and thus the organ of smell, which in the camel is of extraordinary acuteness, is preserved from contact with the hot acrid sand that, like a "pillar of cloud," frequently sweeps across the desert. The extremities only of the two toes which form the foot are free, and are each terminated by a short and somewhat curved nail, the rest of the toes being connected together by means of a broad elastic pad on which the foot rests, and which buoys the camel up as it moves on the soft and ever-shifting surface. The horny callosities on the breast and limb-joints, on which the camel rests when being loaded, may possibly have resulted from the long ages of servitude to which it has been subjected, but whether they existed in the wild camel or not, traces of them are said to be now found on the new-born young. The hump or humps on the camel's back are mere masses of fat, without any corresponding curve on the vertebral column of the animal, and form a reserve of nourishment to be used when other supplies fail; consequently during lengthened periods of privation, and during the rutting season, when the males almost cease to eat, these masses greatly diminish in size. The camel

driver knows well the value of this natural storehouse, and takes care before starting on a lengthened journey to have the humps of his beasts well distended. In its native deserts, however, the camel is more liable to suffer from lack of water than of food, and accordingly the stomach is so modified as to allow of a certain quantity of water being stored for future use. On the walls of the paunch or first stomach, little pouches with narrow mouths are developed; these are the so called "water cells," the biggest of which in an adult camel measures when dilated about three inches in width and depth, and these serve to strain off a considerable quantity of water from the contents of the paunch, retaining it for future use by means of powerful sphincter muscles. The upper divided lip of the camel is slightly extensile, and is used as a feeler with which to touch and examine its food before turning the same into its mouth. The animal is further characterized externally by its long neck, the dusky colour of its fur, the shaggy masses of long woolly hair on certain parts of its body, and the disproportionate shortness of its legs. These, together with the peculiarities already mentioned, combine to make it one of the most ungainly of known animals, and almost justify the recent description given of it by Dr Russell, the *Times* correspondent, as "an abominably ugly necessary animal." Nevertheless, it is as indispensable where great deserts are to be traversed as is the ship on the ocean highway, and this fact seems to have completely blinded the Arab to its undoubted deficiences in form, for in his poetry allusion is sometimes made to the motions of the camel as to a recognized standard of elegance.

The camel is one of the oldest mammals now living, and fossil remains have been found in the Miocene of the Sevalik Hills of a species (*Camelus sivalensis*) somewhat larger, but otherwise scarcely distinguishable from recent forms. "The difference is so slight," says Andrew Murray, "it pleases us to think that we may have here, in this most ancient animal, a species which saw the Miocene epoch, and which has survived all the chances and changes which have taken place since then." That it was one of the earliest of domesticated animals is evident from the frequent allusions made to it in the oldest written records of the human race Six thousand camels are said to have formed part of the wealth of the patriarch Job; they also formed part of the present which Pharaoh gave to Abraham, and it was to a company of Ishmaelites travelling from Gilead to Egypt on camels, laden with spices, much as their Arabian descendants do at the present day, that Joseph was sold by his brethren. Naturalists are able to indicate with more or less certainty the wild progenitors of most of the domestic animals, but they have hitherto failed to obtain any reliable evidence of the existence, at the present day, of the wild ancestor of the camel. In the eastern hemisphere it stands alone, sole representative of the family to which it belongs, its only allies, the llamas, being confined to the slopes of the Andes and the southern parts of South America. Palæontologists, however, by the discovery of several fossil forms, have been able to bridge over the geographical gap which at present separates the two branches of the Camelidæ.

During the rutting season the male camel becomes exceedingly savage and dangerous, and engages in fierce contests with its fellows The gravid female carries her young for fully eleven months, and produces only one calf at a time, which she suckles for a year. Eight days after birth the Arabian camel stands three feet high, but it does not reach its full growth till its sixteenth or seventeenth year. It lives from forty to fifty years. The flesh of the young camel resembles veal, and is a favourite food of the Arabs, while camel's milk forms an excellent and highly nutritious beverage, although, according to Layard, it does not furnish butter. The woolly hair, which grows to a great length on the under side of the neck, the upper part of the legs, and on the humps, is shorn every summer, and is woven into a variety of stuffs used by the Arab for clothing himself and his family, and in covering his tent. It was in raiment of camel's hair that John the Baptist appeared as a preacher. The hair imported into this country is chiefly used in the manufacture of small brushes used by painters, while the thick hide is formed into a very durable leather. The dung is used as fuel, and from the incinerated remains of this sal-ammoniac is extracted, which was at one time largely exported from Egypt.

But it is as "the ship of the desert," without which vast tracts of the earth's surface would probably have remained for ever unexplored, that the camel is chiefly valuable. In its fourth year its training as a beast of burden begins, when it is taught to kneel down and to rise at a given signal, and is gradually accustomed to bear increasing loads. These vary in weight from 500 to 1000 lb, according to the variety of camel employed, for of the Arabian camel there are almost as many breeds as there are of the horse in more temperate regions. When crossing a desert the camels are expected to carry their load 25 miles a day for three days without drink, getting a supply of water, however, on the fourth; but the fleeter varieties will carry their rider and a bag of water 50 miles a day for five days without drinking. When too heavily laden the camel refuses to rise, but on the march it is exceedingly patient under its burden, only yielding beneath it to die; relieved from its load it does not, like other animals, seek the shade, even when that is to be found, but prefers to kneel beside its burden in the broad glare of the sun, seeming to luxuriate in the burning sand. When overtaken by the deadly simoom it falls on its knees, and stretching its snake-like neck along the sand, closes its nostrils, and remains thus motionless till the atmosphere clears; and in this position it affords some shelter to its driver, who, wrapping his face in his mantle, crouches behind his beast. Of still greater service is it, when, the whole caravan being on the point of perishing for want of water, the acute sense of smell which the camel possesses enables it to perceive the presence of water more than a mile off; then it will break its halter and make an unerring track for the well. The food of the camel consists chiefly of the leaves of trees, shrubs, and dry hard vegetables, which it is enabled to tear down and masticate by means of its upper incisors and powerful canine teeth. It is, however, fond of luxurious living when such is to be had, and, according to Sir Samuel Baker, when it arrives in good pasture, after several days of sharp desert marching, it often dies in a few hours of inflammation caused by repletion; but when other animals are starving, the camel, according to the same authority, thrives "on the ends of barren leafless twigs, the dried sticks of certain shrubs, and the tough dry paper-like substance of the dome palm, about as succulent a breakfast as would be a green umbrella and a *Times* newspaper." The docility of the camel has become well-nigh proverbial throughout Europe, but recent travellers who have studied the animal in Arabia and Africa have said much to lessen, if not to extinguish, its reputation in this particular. "If docile means stupid," says Palgrave, who had ample opportunity of observing the camel during his romantic sojourn in Arabia, "well and good; in such a case the camel is the very model of docility. But if the epithet is intended to designate an animal that takes an interest in its rider so far as a beast can, that in some way understands his intentions, or shares them in a subordinate fashion, that obeys from a sort of submissive or half-fellow-feeling with his master, like the horse or elephant, then I say that the camel is by no means docile—very much the contrary. He takes no heed of his rider, pays no attention whether he be on his back or not, walks straight on when

once set agoing, merely because he is too stupid to turn aside, and then should some tempting thorn or green branch allure him out of the path, continues to walk on in the new direction simply because he is too dull to turn back into the right road. In a word, he is from first to last an undomesticated and savage animal rendered serviceable by stupidity alone, without much skill on his master's part, or any co-operation on his own, save that of an extreme passiveness. Neither attachment nor even habit impress him; never tame, though not wide-awake enough to be exactly wild." So also Sir S. Baker, in his recent work *The Albert Nyanza*, bears testimony to its extreme dulness, for while other ruminants in feeding select wholesome herbs, the camel is stupid enough to eat indiscriminately every green vegetable; it is thus often poisoned through eating a plant known to the Arabs as "camel poison," and on this account it is customary to set watchers over them while grazing in districts where this plant is found. The camel, however, is revengeful, and in satisfying this passion is said to display a far-thoughted malice scarcely consistent with the extreme stupidity attributed to it by Palgrave. Of this vindictiveness the camel driver is well aware, and of the certainty that sooner or later it will seek revenge; accordingly it is customary for the person who has reason to fear its malice to throw his clothes before the camel, meanwhile concealing himself until the infuriated animal has expended its rage in tossing and trampling upon them, when the injury, real or supposed, is immediately forgotten.

The camel is probably a native of the desert countries of the south-west of Asia, whence it has spread into most of the arid regions of the eastern hemisphere, carrying with it wherever it goes a mark of its desert origin in the antipathy which it shows to cross a stream of water. It has lately been introduced into Australia, the great central desert of which was recently crossed by Warburton with a caravan of camels. It has now also obtained a footing in the New World, ten camels having been landed at New York some years ago, all of them, however, with the exception of a single male and female, dying soon after. The surviving pair were transferred to Nevada, where the soil was sandy and sterile, producing abundance of prickly shrubs which no other animal would touch, but on which the pair of camels flourished and bred. This female has already given birth to twenty-four young, all of which are still (1875) alive, and some of these having also bred, there are now ninety-six camels, all, with the exception of the original couple, born in Nevada. In Europe the camel is only reared in the neighbourhood of Pisa, having been introduced there by one of the dukes of Tuscany, and is employed as a beast of burden, but is said to be gradually deteriorating.

There are two species of camel—the Arabian and the Bactrian. The former or single-humped species (*Camelus dromedarius*) is found in greatest perfection in Arabia, whence it has spread eastwards to India, where it is now extensively used, although the stony nature of much of the ground it has to pass over does not give it in India that superiority over other beasts of burden, which it undoubtedly possesses in desert countries. It seems to have spread westwards with the Koran along the North African shores, and to have been introduced by the Moors into Spain, where, however, it did not succeed in establishing itself. It also accompanied the followers of Mahomet into European Turkey. In Arabia several breeds, each possessing special qualities, are carefully cultivated. The chief of these are the thick-built, heavy-footed, and slow-paced variety, used for carrying heavy loads, and the dromedary—a name often applied to all the members of the single-humped species, but properly belonging *only* to a thin, comparatively elegant, and fine-haired breed, celebrated for its fleetness, carrying its rider when necessary 100 miles a day. The dromedary, says Palgrave, "is the race-horse of its species," and the difference between it and the heavy variety is exactly the same "as between the race-horse and a hack." Another breed, belonging to a tribe of Arabs who dwell near the western shores of the Red Sea, is specially adapted for journeying with loads over mountainous districts, and Baker, who made use of them, states that they accomplished feats in mountain climbing which would have been impossible to any other domestic animal so loaded. The Bactrian or two-humped camel (*Camelus bactrianus*) is a somewhat larger and more robust species, and is much rarer than the Arabian. It is found throughout the region lying to the north and east of that inhabited by the dromedary, from the Black Sea to China and northward to Lake Baikal, where in winter it sustains severe cold, subsisting meanwhile upon the leaves and twigs of the willow and birch. The pads on its feet are harder than in the other species, and are thus better fitted to bear the changes wrought on the soil by the frequent alternations of rain and drought, while its fur is also thicker and more plentiful. In Central Asia both species occur, and hybrids are not uncommon, the latter being, it is alleged, occasionally fertile among themselves. (J. GI.)

CAMELLIA, the name of a genus of *Ternströmiaceæ*, remarkable for its evergreen laurel-like foliage, and its handsome rose-like flowers, whence the common species, *C. japonica*, is sometimes called the Japan rose. This is an evergreen shrub of remarkably hardy constitution, so that in our climate it flourishes perfectly in a cold greenhouse; indeed, in the south and west of England, and in other favourable situations, the plant itself is hardy, and only suffers from frost in regard to the damage done to its flowers, which are naturally developed very early in the spring, and are therefore liable to suffer injury from spring frosts. The plant had been cultivated by the Japanese and Chinese long previous to its introduction to our gardens from China in 1739, and, in consequence, numerous double-flowered varieties were at that time known, of which about two dozen sorts were introduced from China, chiefly between 1806 and 1824, some two or three others having been obtained so early as 1792–4. This number of varieties has now been very considerably increased by the production of European seedlings, so that several hundreds are figured in a publication called *Nouvelle Iconographie des Camellias*, specially devoted to their illustration. The plant seeds freely in the climate of Italy and the south of Europe, and thence many first-rate sorts have been obtained.

The original type of *C. japonica* forms a dense bushy evergreen, abundantly clothed with ovate acuminate glossy leaves, and decorated with sessile single red flowers composed of from five to seven (nominally five) broadly obovate rosy carmine petals, which expand into a cup-shaped flower, and surround a circlet of numerous monadelphous stamens, within which a few free stamens, two to each petal, are produced. These stamens afford a fine contrast to the broad spreading petals. This form, or one but slightly removed from it, is still cultivated in gardens, as a stock on which to graft the double-flowered sorts, these only, in a general way, being now prized. There are, however, some few exceptions, as, for example, the single white, whose large flowers, with their conspicuous stamens, are extremely handsome when associated with the rich-looking dark green foliage.

The name *Camellia* was given to these plants by Linnæus in honour of George Joseph Camellus or Kamel, a Moravian Jesuit, who travelled in Asia, and wrote a history of the plants of the island of Luzon. In Japan, its native country, the *Camellia* attains to the size of a large tree, and it is held in high estimation by the Japanese on account of the extreme beauty of its large, showy, and

various-coloured flowers, which, however, have this drawback, that they have no scent. It appears to have been cultivated by the Chinese from time immemorial, and all our earlier introductions were obtained from that country. According to the *Hortus Kewensis*, it was introduced into England by Robert James, Lord Petre, before the year 1739; and the Waratah, or anemone-flowered variety, which has broad outer petals and a crowd of smaller central ones, is said to have been introduced at the same time. The double white, a variety as yet unsurpassed in beauty, its flowers being so pure in colour, and so full and symmetrically imbricated in form, was introduced in 1792; as also was the double striped, a free blooming hardy kind, with rosy red flowers irregularly blotched with white, which though surpassed in size and richness of colouring by more modern European varieties, is still too useful to be altogether discarded. The latest direct importations are probably the hexangular-flowered Camellia (*hexangularis*), introduced from China by Mr Fortune in 1846, a variety which, like that called Lady Hume's Blush (*incarnata*), has the pointed petals laid directly over each other, so that the face of the flower becomes six-angled; and the fish-tailed Camellia, introduced in 1861, a variety in which the leaves are sharply serrated at the margin and forked at the apex, so that they resemble in form the tail of a fish.

To be seen in their full perfection Camellias should be planted out in borders of properly prepared soil under glass; but these borders should be very effectually drained, and of such a mechanical composition as never to become soddened, for the plants require to be almost deluged with water when making their growth, and when developing their blossoms. The borders, moreover, when the plants have become well established, and the soil is full of roots, will require to be assisted by top-dressings, such as sheep or deer dung, and by applications of liquid manure. They by no means require a heated structure, nor too much sunlight, but when well established in a cool and somewhat shaded conservatory, may become a source of infinite delight to those who have a love for flowers. As instances of the great esteem in which the *Camellia* is held, it is only necessary to refer to the immense number of cut blooms sold during the season in Covent Garden market, and the high prices which they realize while yet comparatively scarce.

The genus *Camellia* is limited to some six or seven species, natives of India and Japan. Of these, besides *C. japonica*, another named *C. reticulata*, a native of the island of Hong-Kong, is highly prized in gardens for its very handsome blossoms. It differs from *C. japonica* in its downy branches, and reticulated, not glossy leaves, and also in its much larger flowers. The double-flowered variety of this plant has a most gorgeous appearance, specimens of the flowers having been measured which were as much as twenty inches in circumference.

Both *C. Sasanqua* (=*oleifera*), and *C. drupifera* (=*Kissii*), the former inhabiting Japan and China, the latter Cochin-China and the mountains of India, are oil-yielding plants. The oil of *C. Sasanqua* (of which Sasankwa is the native Japanese name) has an agreeable odour, and is used for many domestic purposes; it is obtained from the seeds by subjecting them to pressure sufficient to reduce them to a coarse powder, and then boiling and again pressing the crushed material. The leaves are also used in the form of a decoction by the Japanese women, for washing their hair; and in a dried state they are mixed with tea on account of their pleasant flavour. The oil of *C. drupifera*, which is closely allied to *C. Sasanqua*, is used medicinally in Cochin-China, its flowers also are odoriferous, all the other known species, except the Indian *C. lutescens*, being inodorous.

The genus *Camellia* is very closely allied to that of the tea-plant (*Thea*); indeed so close is the affinity that some botanists have proposed to unite them. Dr Seemann, however, in a memoir published in the *Transactions of the Linnean Society* (xxii. 337), points out their distinctions, from which it appears that while in *Camellia* the flowers are erect and sessile, the calyx many-leaved with deciduous sepals, the interior stamens (those within the monadelphous ring) twice the number of petals, and the styles five in number, the flowers of *Thea* are pedunculate and nodding, the calyx five-sepaled with persistent sepals, the interior stamens equalling the petals in number, and the styles three. So close, however, is the agreement between them that the red-flowered *Camellia Sasanqua*, as it was for a long time called in gardens, has, as a result of more intimate acquaintance with its structure, to be referred to *Thea*, under the name of *Thea maliflora*. Bentham and Hooker, in their new *Genera Plantarum*, have again united *Thea* with *Camellia* under the latter name, preferring to regard the teas as forming a section of the genus *Camellia*, which conclusion has been adopted by Professor Dyer in the *Flora of British India* (i. 292), where the *Thea assamica* of authors is referred to as the possible wild stock of the tea-plant, and the name of *Camellia theifera* adopted for the combined form called *T. chinensis* by Linnæus and Seemann. (T. MO.)

CAMEO, a term of doubtful origin, applied to engraved work executed in relief, on hard or precious stones, on imitations of such stones in glass called "pastes," or on the shells of molluscous animals. A cameo is thus the converse of an intaglio, which consists of an incised or sunk engraving executed in the same class of materials. The word cameo is generally regarded as being derived from the Arabic *camea*, a charm or amulet; but a number of other derivations have been suggested, among which a highly allegorical origin of the word from the Arabic *camaut*, the camel's hump, implying any object in relief, has been maintained by an eminent authority. Cameo-cutting is an art of much more recent introduction than the sister art of intaglio-engraving. The earliest known traces of any attempt at cutting gem-figures in relief are seen in certain Phœnician and Etruscan scarabei, in which the back of the beetle has been utilized for the faint delineation of another and quite different figure. One of the most ancient known cameos, of which the date can be fixed with certainty, consists of a sardonyx of three layers with portrait heads of Demetrius Soter and his wife Laodice, which must have been engraved between the years 162 and 150 B.C.

The materials which ancient artists used for cutting into cameos were chiefly those siliceous minerals which, under a variety of names, present various strata or bands of two or more distinct colours, and properly the name cameo should be restricted to work executed in relief on such banded stones. The minerals, under different names, are essentially the chalcedonic variety of quartz, and the differences of colour they present are due to the presence of variable proportions of iron and other foreign ingredients. These banded stones, when cut parallel to the layers of different colours, and when only two coloured bands—white and black, or sometimes white and black and brown—are present, are known as onyxes, but when they have with the onyx bands layers of carnelian or sard, they are termed sardonyxes. The sardonyx, which was the favourite stone of ancient cameo-engravers, and the material in which their masterpieces were cut, was procured from India, and the increased intercourse with the East by the way of Egypt after the death of Alexander the Great had a marked influence on the development of the art. Cameo-cutting in Rome attained the zenith of its pristine perfection during the first two centuries of the Christian era, the chief works being portraits of the reigning families, and allegorical illustrations of their glories. Contemporaneously with the production of the finest works in Oriental precious stones, pastes or imitations in glass were made in incredible numbers to meet the requirements of the classes who could not afford the other necessarily rare and costly luxuries. Both in perfection of material and in artistic merit these imitations were, in the best period, of extraordinary merit. The Barberini or Portland vase in the British Museum is a rare example of the skill of both the glass-worker and engraver on glass of ancient times.

The two most famous examples of this art which have come down to the present day are the Great Agate of the Sainte Chapelle in the Bibliothèque Nationale, Paris, and the Augustus Cameo in the Vienna collection. The former

was pledged among other valuables in 1244 by Baldwin II. of Constantinople to Saint Louis. It is mentioned in 1344 as "Le Camahieu," having been sent in that year to Rome for the inspection of Pope Clement VI. It is a sardonyx of five layers of irregular shape, like all classical gems, measuring about 13 inches by 11 inches. During the Middle Ages the subject was supposed to be the triumph of Joseph in Egypt; but it is now known to represent on its upper part the apotheosis of Augustus, the centre being occupied with the reception of Germanicus on his return from his great German campaign by the Emperor Tiberius and his mother Livia. The lower division is filled with a group of captives in attitudes expressive of woe and deep dejection. The Vienna gem (*Gemma augustea*), an onyx of two layers measuring 9 inches by 8, is a work of still greater artistic interest The upper portion is occupied with an allegorical representation of the coronation of Augustus,—the emperor being represented as Jupiter with Livia as the goddess Roma at his side. In the composition Neptune and Cybele, with several members of the family of Augustus, are introduced, and on the exergue or lower portion are Roman soldiers preparing a trophy, barbarian captives, and female figures. The history of this inestimable treasure has been traced from the time of the Crusades, and it came into the possession of the Emperor Rudolph II. in the 16th century for the enormous sum of 12,000 gold ducats

While these and other similar monuments of antiquity, which have come down to us only mellowed and not injured by time, have intrinsically a priceless value as the expression of the most perfect artistic culture and feeling of the age to which they belong, they possess at the same time equally great significance to the student of the history, civilization, morals, and manners of the period. They supply the most authentic means of confirming the inferences to be drawn from classical sources as to beliefs, usages, dress, domestic and public habits, and pursuits of the people with whom they deal, and by means of such gems not only are the prevailing features of an ancient race accurately delineated, but the actual portraits of many of the most prominent personages in the world's history have been faithfully preserved, and can be identified beyond the shadow of a doubt.

The art of cameo-engraving waned in the early part of the 3d century, after the death of the Emperor Severus, but under the first Christian Emperor Constantine it enjoyed a brief period of revival. Many very beautiful cameo portraits of Constantine are extant; and it was during or shortly after his reign that Christian Scripture subjects began to appear on cameos. That class of subjects constituted the staple of such work—generally rude and artistically debased—as continued to be cultivated under the Byzantine empire down to nearly the epoch of the Renaissance. From the Byzantine period downward one peculiarity of gem-engraving becomes noticeable. Cameo-work as compared with intaglios in classical times was rare and infrequent, but now and onwards the opposite is the case, intaglio-sinking having almost died out, and cameos being chiefly produced. Commercial intercourse with the East still secured for the engravers a supply of magnificent sardonyxes, although blood-stone and other non-banded stones were very commonly used for works in relief. Cameos during the long dark ages were used chiefly for the decoration of reliquaries and other altar furniture, and as such their designs were purely ecclesiastical or scriptural. To this period also belongs the class of complimentary or motto cameos, which, containing only inscriptions and an ornamental border, executed in nicolo stones, were used as personal gifts and adornments.

In mediæval times antique cameos were held in peculiar veneration on account of the belief, then universal, in their potency as medicinal charms. This power was supposed to be derived from their origin, of which two theories, equally satisfactory, were current. By the one they were held to be the work of the children of Israel during their sojourn in the wilderness (hence the name *Pierres d'Israel*), while the other theory held them to be direct products of nature, the engraved figures pointing to the peculiar virtue lodged in them.

The revival of the glyptic arts in Western Europe dates from the pontificate of the Venetian Paul II. (1464–71), himself an ardent lover and collector of gems, to which passion, indeed, it is gravely affirmed he was a martyr, having died of a cold caught by the multiplicity of gems exposed on his fingers. The cameos of the early part of the 16th century rival in beauty of execution the finest classical works, and, indeed, many of them pass in the cabinets of collectors for genuine antiques, which they closely imitated. The Oriental sardonyx was not available for the purposes of the Renaissance artists, who were consequently obliged to content themselves with the colder German agate onyx. The scarcity of worthy materials led them to use the backs of ancient cameos, or to improve on classical works of inferior value executed on good material, and probably to this cause must also be assigned the introduction of shell cameos, which are not supposed to have been made previous to this period.

Among the means of distinguishing antique cameos from cinquecento work, the kind of stone is one of the best tests, the classical artists having used only rich and warm-tinted Oriental stones, which further are frequently drilled through their diameter with a minute hole, from having been used by their original Oriental possessors in the form of beads. The cinquecento artists also, as a rule, worked their subjects in high relief, and resorted to undercutting, no case of which is found in the flat low work of classical times. The projecting portions of antique work exhibit a dull chalky appearance, which, however, fabricators learned to imitate in various ways, one of which was by cramming the gizzards of turkey fowls with the gems. Another index of antiquity is found in the different methods of working adopted in classical and Renaissance times. The tools employed by the Renaissance engraver were the drill and the wheel, both fed with oil and diamond or emery dust. The drill was simply the common instrument known by that name, and the wheel was a small metallic disc, which cut by its periphery being made to rotate in a vertical plane. Antique gems of the best period were cut or scratched (γλύφειν, *scalpere*) with the diamond point (splinters either of corundum or sapphire), with the aid of the drill, which the artists possessed in common with their modern successors.

In the early part of the 18th century great confusion was introduced into the study of this department of art, by the fraudulent insertion on a wholesale scale of names in Greek, purporting to be those of the engravers of the gems bearing them. In reality the insertion of his name by any artist, on cameos especially, was an exceedingly rare occurrence. An invariable and unfailing test of the authenticity of any signature on a cameo is "that it be always in relief, which is a sure evidence that it was cut at the same time with the rest of the composition." Another fraud practised in Italy during the revival consisted in engraving on unnamed portrait gems a name supposed to suit the aspect of the individual.

In our own day the engraving of cameos has ceased to be pursued as an art. Roman manufacturers cut stones in large quantities to be used as shirt-studs and for setting in finger-rings; and in Rome and Paris an extensive trade is carried on in the cutting of shell cameos, which are

largely imported into England and mounted as brooches by Birmingham jewellery manufacturers. The principal shell used is the large bull's-mouth shell (*Cassis rufa*), found in East Indian seas, which has a sard-like underlayer. The black helmet (*Cassis tuberosa*) of the West Indian seas, the horned helmet (*C cornuta*) of Madagascar, and the pinky queen's conch (*Strombus gigas*) of the West Indies are also employed. The famous potter Josiah Wedgwood introduced a method of making imitations of cameos in pottery by producing white figures on a coloured ground, this constituting the peculiarity of what is now known as Wedgwood ware. (J. PA.)

CAMERA LUCIDA, an instrument invented by Dr Wollaston for drawing in perspective.

If a piece of plane glass be fixed at an angle of 45° with the horizon, and if, at some distance beneath, a sheet of paper be laid horizontally on a table, a person looking downwards through the glass will see an image of the objects situated before him; and as the glass which reflects the image is also transparent, the paper and pencil can be seen at the same time with the image, so that the outline of the image may be traced on the paper. The image is an *inverted* one. This is the simplest form of the instrument, and may be constructed extemporaneously by fixing on a stand a plane transparent glass, with its surfaces ground parallel, or a piece of Muscovy glass, at an angle of 45° with the horizon. A card with a small hole in it will serve as a sight for keeping the eye steady in one situation whilst the pencil is tracing the image.

Let a plane mirror, *cb* (Plate XXXIV. fig. 1), be inclined at an angle of 22½° with the horizon, and let *ba*, a piece of plane transparent glass, be so placed as to make an angle of 22½° with the vertical, then rays *fg* from an object will be twice reflected before they reach the eye at *e*, and, consequently, on looking down through the transparent glass, an *erect* image is seen, and the pencil may be drawn over the outlines of this image, so as to leave a perspective representation on the paper.

As the image and pencil are at different distances, they cannot be both seen in the same state of the eye. To remedy this inconvenience, a convex glass is used, of such focus as to require no more effort than is necessary for seeing the distant objects distinctly. By means of this lens, the image will appear as if it were placed on the surface of the paper. In fig. 1, *bd* is a convex glass of 12 inches focus. Instead of using a convex lens, short-sighted persons will require a concave glass to be placed at *f*, in the course of the rays from the object to the reflecting surface. In fig. 2, *ik* is a concave glass so placed that it may be turned at pleasure into its place, as the sight of the observer may require. Persons whose sight is nearly perfect may use either the concave glass placed before the reflecting surface, or the convex placed between the paper and the eye.

In the actual construction of the instrument, a prism is used instead of a mirror and plane glass. The rays from the object fall upon the surface *bc* of the prism, fig. 3. This surface *bc* is inclined 22½° to the horizon. The refractive power of the glass allows none of the rays in this situation to pass out; they are all reflected from the surface *bc* to the surface *ab*, and from that to the eye. *ab* makes an angle of 135° with *bc*, and 22½° with the vertical. The eye cannot see the pencil through the prism as it does through a plane glass; therefore, in order that the pencil may be seen, the eye must be so placed that only a part of the pupil may be above the edge of the prism, as at *e*, fig. 3; and then the reflected image will be seen at the same time with the paper and pencil. There is a small piece of brass perforated with a hole *c* (fig. 2), and moving on a centre; this serves to keep the eye in one position, as it must be that the image may be steady, and also to regulate the relative quantities of light to be received from the object and from the paper.

The instrument, being near the eye, does not require to be large. The smallest size which can be executed with accuracy is to be preferred, and is such that the lens is only three-fourths of an inch in diameter. Fig. 4 shows the instrument on its stand, and clamped to a board. The joint by which the prism is attached to the stand is double.

This instrument serves for drawing objects of all forms, and consequently also for copying lines already drawn on a plane surface. If it is required that the copy shall be of the same size as the original drawing, the distance of the drawing from the prism should be the same as the distance of the paper from the eye-hole. No lens will be necessary in this case, because the image and the paper, being both at the same distance from the eye, coincide without the aid of a glass.

In order to have a reduced copy of a drawing, the drawing is to be placed at a distance from the prism greater than the distance of the paper from the eye-hole. If the distance is twice as great, a copy will be obtained in which the lines are of one-half the size of the lines in the original, and so in proportion for other distances. A lens is necessary, that the eye may be enabled to see at two different distances; and, in order that one lens may serve, the distance between the eye-hole and the paper should be variable; to that effect the stand is susceptible of being lengthened or shortened at pleasure.

The length of the stem is adjusted upon optical principles. When a distant object is to be delineated, the rays coming from it, and reflected by the instrument to the eye, are parallel, and it is required that the rays proceeding from the paper to the eye should also be parallel. This is accomplished by interposing a lens between the paper and the eye, with its principal focus on the paper. When the object to be delineated is so near that the rays which come from it to the eye are divergent, then it is required that the rays from the paper should likewise be divergent in the same degree, in order that the paper and the image may both be seen distinctly by the same eye; for this purpose the lens must be placed at a distance from the paper less than the distance of its principal focus.

The advantage of this instrument as compared with the camera obscura are,—1*st*, That it is small and easily carried about; 2*dly*, That no lines are distorted, not even those most remote from the centre; and 3*dly*, That in the field of the camera lucida 70° or 80° may be included, whilst the distinct field of the camera obscura does not extend beyond 30° or 35° at most. See *Repertory of Arts*, vol. x., 1807, p. 162, and Nicholson's *Journal*, vol. xvii.

If the camera lucida be fixed at the eye-glass of a telescope, it will reflect to the eye the image of the objects in the field of the telescope, so that a drawing of the image may be made. See Brewster's *Account of some Philosophical Instruments*. A plane reflecting glass fixed at an angle of 45° with the horizon, and placed so as to receive the rays from the eye-glass of a telescope, will also give an image of the objects in the field, so situated that the image may be traced with a pencil. Varley's patent graphic telescope is upon this principle. In order that the field may be large, the magnifying power of the telescope should be small.

The optigraph of Ramsden and Thomas Jones, described in the *Philosophical Magazine*, vol. xxviii., 1807, p. 67, is an instrument of a similar kind. The image of the object is seen in a telescope. There is a piece of plane glass near *c*, in the focus of the eye-glass of the telescope F, Plate XXXIV. fig. 5. On the centre of this piece of glass is a dot; *a* is a plane mirror, inclined so as to reflect the image of the object into the telescope. This mirror remains fixed, whilst

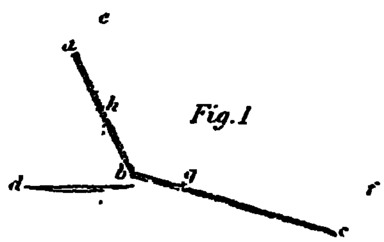


Fig.1

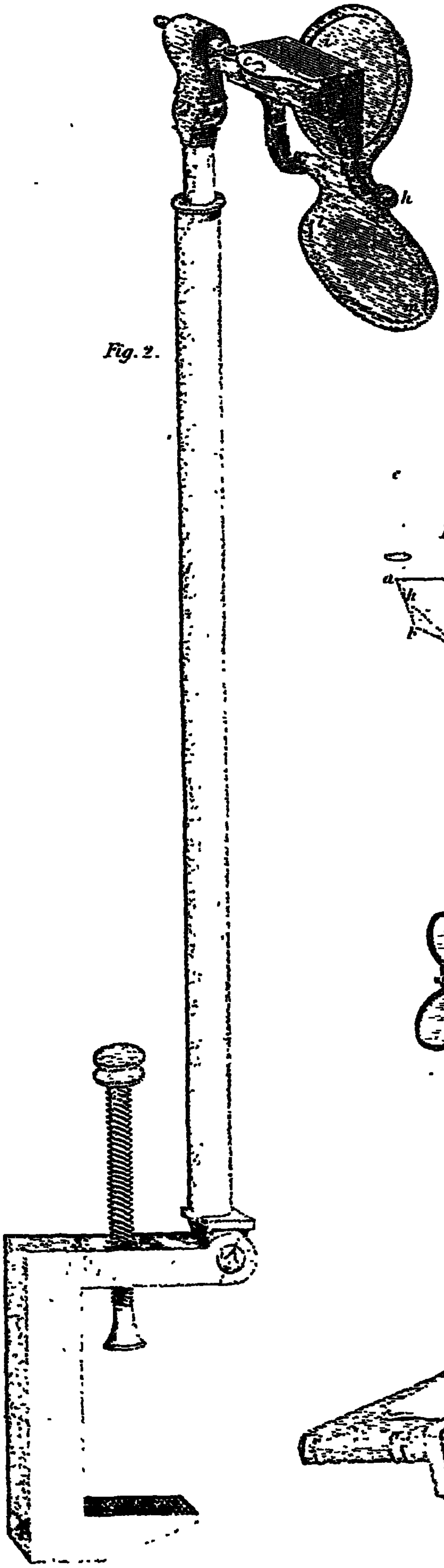


Fig. 2.

Fig.3. Prism of Camera

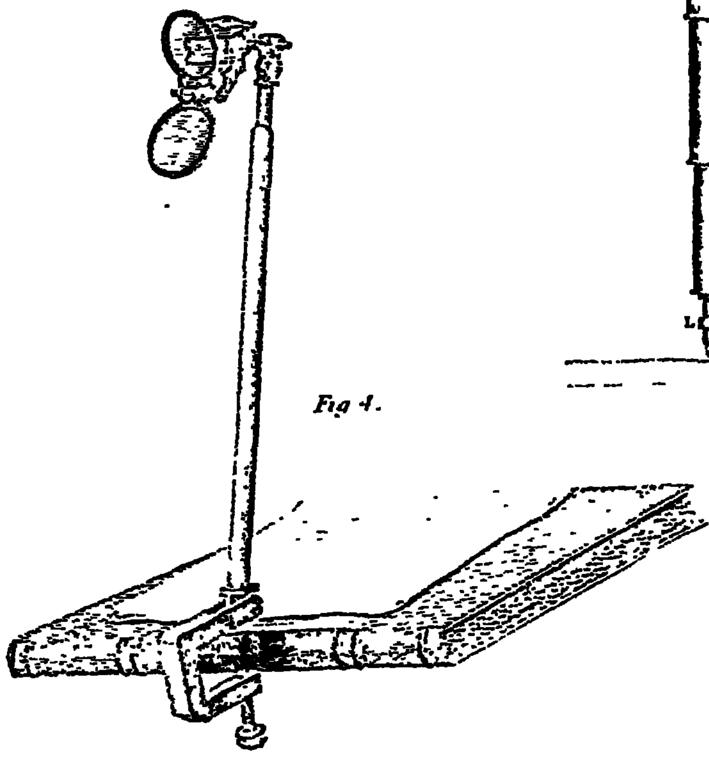


Fig 4.

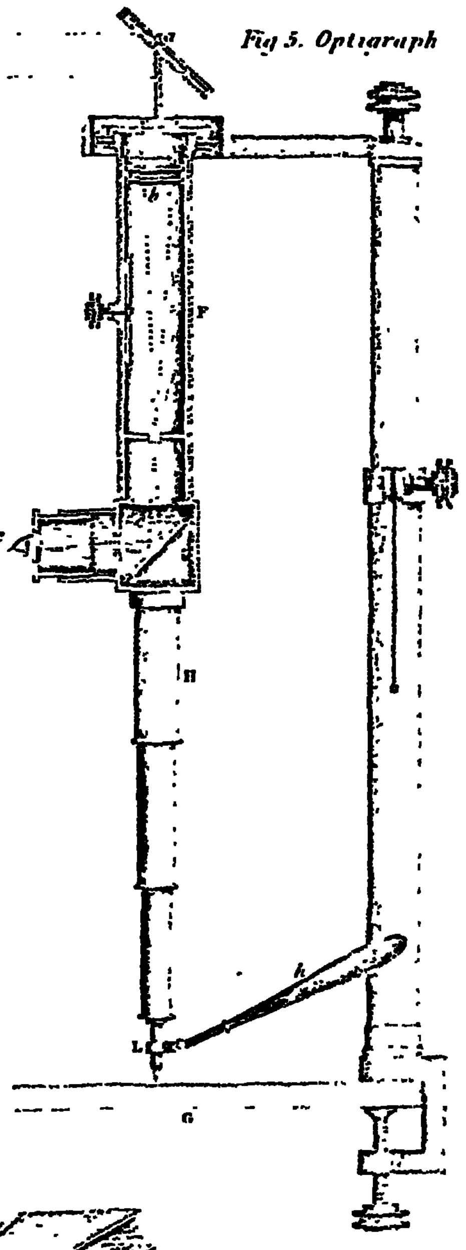


Fig 5. Optigraph

the telescope is movable on a universal joint at its object-glass *b*. Near *c* is another plane mirror, which reflects the rays to the eye-glass. The eye being placed at the eye-glass at *e*, the telescope is to be moved by the handle *h* so that the dot in the focus of the eye-glass shall pass over the outlines of the image seen by the eye, and the pencil at L performing a similar motion to that of the dot, and sliding freely in its sheath, presses with its weight on the paper; a drawing of the object is the result. If the stand and slider H be lengthened, an enlarged drawing will be obtained.

CAMERA OBSCURA, an optical apparatus, consisting of a darkened chamber, at the top of which is placed a box or lantern, containing a convex lens and sloping mirror, or a prism combining the lens and mirror. The rays of light from surrounding objects are received by the lens, and the mirror reflects images of the scenery downwards on a table placed underneath. This ingenious contrivance is said to have been invented by Baptista Porta in the end of the 16th century. For the camera obscura used by photographers see PHOTOGRAPHY.

CAMERARIUS, JOACHIM (1500-1574), whose family name was Liebhard, one of the most learned classical scholars of his time, was born at Bamberg on the 12th April 1500. He studied at Leipsic, Erfurt, and Wittenberg, and in the last-mentioned town he enjoyed the friendship of Melanchthon. For some years he was teacher of history and Greek at the Gymnasium, Nuremberg. In 1530 he was sent as deputy for Nuremberg to the Diet of Augsburg, where he rendered important assistance to Melanchthon. Five years later he was commissioned by Duke Ulrich of Würtemberg to reorganize the university of Tübingen; and he subsequently rendered a similar service at Leipsic, where the remainder of his life was chiefly spent. He translated into Latin Herodotus, Demosthenes, Xenophon, Homer, Theocritus, Sophocles, Lucian, Theodoret, Nicephorus, and other Greek writers. He published upwards of 150 works, including a *Catalogue of the Bishops of the principal Sees*; *Greek Epistles*; *Accounts of his Journeys*, in Latin verse; a Commentary on Plautus; *Euclid*, in Latin; and the Lives of Helius Eobanus Hessus and Philip Melanchthon. He died at Leipsic in 1574.

CAMERARIUS, JOACHIM (1534-1598), a learned physician, son of the preceding, was born at Nuremberg, 6th November 1534. After having finished his studies in Germany he visited Italy, where he graduated as doctor of medicine. On his return he was invited to reside at the courts of several princes; but he was too much devoted to the study of chemistry and botany to accept their offers. He settled in his native town of Nuremberg, where he practised as a physician, and was the chief agent in founding a medical school. He wrote a *Hortus Medicus*, and several other works. He died on the 11th October 1598.

CAMERINO, formerly the capital of a delegation of the same name in the States of the Church, and now the chief town of a district, in the province of Macerata, in Italy, is situated on a height at the foot of the Apennines, 41 miles W. of Ancona. It is the seat of an archbishop, and possesses a small university founded in 1727, a theological seminary, nineteen conventual buildings, and a bronze statue of Pope Sixtus V., dating from 1587. Its cathedral, Sansovino, is built on the site of an ancient temple to Jupiter, and contains a number of excellent paintings. The culture and manufacture of silk is by far the most important branch of industry; to which may be added the preparation of leather. Camerino occupies the site of the ancient *Camerinum*, an Umbrian city, whose inhabitants, the *Camertes*, are mentioned as an important people at a very early date. About the beginning of the Christian era its lands were bestowed on military colonists; but it continued to enjoy considerable prosperity. In the Middle Ages it originally formed part of the duchy of Spoleto; but it passed in the 13th century to the Varani family, and in 1520 was made an independent duchy by Leo X. About seventy years afterwards it was incorporated by the Papal States. The painter Carlo Maratta, the last of the so-called Roman school, was a native of the city. Population, 11,880.

CAMERON, JOHN (1579-1623), a learned theologian, was born at Glasgow about 1579, and received his early education in his native city. After having taught Greek in the university for twelve months, he removed to Bordeaux, where he was soon appointed a regent in the College of Bergerac. He did not remain long at Bordeaux, but accepted the offer of a chair of philosophy at Sedan, where he passed two years. He then returned to Bordeaux, and in the beginning of 1604 he was nominated one of the students of divinity who were maintained at the expense of the church, and who for the period of four years were at liberty to prosecute their studies in any Protestant seminary. During this period he acted as tutor to the two sons of Calignon, chancellor of Navarre. They spent one year at Paris, and two at Geneva, whence they removed to Heidelberg, where they remained nearly twelve months. In this university, on the 4th of April 1608, he gave a public proof of his ability by maintaining a series of theses, *De triplici Dei cum Homine Fœdere*, which were printed among his works. The same year he was recalled to Bordeaux, where he was appointed the colleague of Dr Primrose; and when Gomarus was removed to Leyden, Cameron, in 1618, was appointed professor of divinity at Saumur, the principal seminary of the French Protestants.

In 1620 the progress of the civil troubles in France obliged Cameron to seek refuge for himself and family in England. For a short time he read private lectures on divinity in London; and in 1622 the king appointed him principal of the university of Glasgow in the room of Robert Boyd, who had been removed from his office in consequence of his adherence to Presbyterianism. His successor appears to have been more favourably inclined to Episcopacy,—a circumstance that may have tended to diminish the cordiality of his reception in his native city. Here he also taught divinity with great reputation, but he resigned his office in less than a year. Calderwood says that "Cameron was so misliked by the people that he was forced to quit his place soon afterwards."

He returned to France, and fixed his residence at Saumur; and after an interval of a year he was appointed professor of divinity at Montauban. The country was still torn by civil and religious dissensions; and as Cameron maintained the doctrine of passive obedience, he excited the indignation of the more strenuous adherents of his own party. He withdrew to the neighbouring town of Moissac; but he soon returned to Montauban, and a few days afterwards he died at the age of about forty-six. Cameron left by his first wife several children, whose maintenance was undertaken by the Protestant churches in France. All his works were published after his death.

His name has furnished a designation to a party of Calvinists in France, who asserted that the will of man is only determined by the practical judgment of the mind; that the cause of men's doing good or evil proceeds from the knowledge which God infuses into them; and that God does not move the will physically, but only morally, by virtue of its dependence on the judgment of the mind. This peculiar doctrine of grace and free-will was adopted by Amyraut, Cappel, Bochart, Daillé, and others of the more learned among the Reformed ministers, who judged Calvin's doctrines on these points too harsh. The Cameronites are moderate Calvinists, and approach to the opinion of the Arminians. They are also called

Universalists, as holding the universal reference of Christ's death, and sometimes Amyraldists. The rigid adherents to the Synod of Dort accused them of Pelagianism, and even of Manicheism, and the controversy between the parties was carried on with great zeal; yet the whole question between them was only, whether the will of man is determined by the immediate action of God upon it, or by the intervention of a knowledge which God impresses on the mind. The Synod of Dort had laid down the position that God not only illuminates the understanding, but gives motion to the will by making an internal change therein; whereas Cameron admitted only the illumination by which the mind is morally moved, and attempted to explain the decision of the Synod of Dort so as to make the two opinions consistent.

CAMERON, Richard (? –1680), the founder of the Cameronians, was born at Falkland, in the county of Fife. The date of his birth is not known. His father, who was a shopkeeper in that town, gave him such an education as the village school afforded; and his success was so great that, while still a youth he was appointed schoolmaster. In this situation he had opportunities of becoming acquainted with some of the more enthusiastic field-preachers, who at this time wandered through the country disseminating their doctrines. Persuaded by them he resigned his situation, and shortly after entered the family of Sir Walter Scott of Harden as chaplain and tutor. He did not remain there long, however, for, refusing to acknowledge the Indulgence, he joined the ranks of the nonconforming ministers, and incited the inhabitants of the southern counties of Scotland to protest openly against the new edict. So formidable was the agitation that the Government thought fit to interfere, and pronounced illegal all armed assemblages for religious purposes. Cameron was obliged to take refuge in Holland, where he resided for some time; but in the spring of 1680 he returned to Scotland, and once more made himself formidable and obnoxious to the Government. Shortly after the defeat of the Covenanters at Bothwell Bridge in that year, Cameron was slain in a skirmish at the Aird's Moss, fighting bravely at the head of the few troops which he had been able to collect, and which formed the nucleus of the renowned regiment in the British army afterwards known by his name.

CAMEROONS, or perhaps preferably Camaroons, is the greatest mountain-mass on the western coast of Africa. It is situated at the angle of the Bight of Biafra, directly opposite the island of Fernando Po, with which it has evidently an intimate geological connection. Its European name is said to be derived from the Portuguese Camarões (shrimps or prawns), and to have been bestowed by the early discoverers on the neighbouring coast from the abundance of its crustacea. The native designation of the highest peak is Mongo-má-Lobá, or the Mountain of the Sky, and the whole upper region is usually called Mongo-mo-Ndemi, or the Mountain of Greatness. The area of the Cameroons proper is calculated at about 380 square miles; but offshoots and underfalls seem to stretch both north and south for considerable distances. The pile is of distinctly volcanic formation, and the higher district contains numerous craters and lava-beds of comparatively recent date. On the principal summit, whose twin peaks of Mount Albert and Victoria rise to a height of about 13,120 feet above the sea-level, there are one small and two large craters, from which, if native report can be trusted, eruptions have taken place within the memory of man (1838). The lower portions of the mass are occupied by a luxuriant vegetation of palms, acacias, fig-trees, kokos, plantains, and a rich variety of tree and shrub; while at the height of about 7000 feet these give place to ferns, grasses, and heaths. The climate of the middle zone would render it an excellent site for a sanatorium for Europeans debilitated by the malaria of the neighbouring coasts; and the fertility of the soil would soon raise the district to great commercial importance, if it were brought under cultivation. The native tribes which inhabit the mountain sides are comparatively few, and have a very small proportion of the surface in actual possession. To the south of the Cameroons lies the Bay of Ambas (Ambozes, or Amboize), with the two islands of Ndami and Mondori. It forms a well-sheltered harbour, and is capable of receiving the largest vessels. In 1837 the king of Bimbia on the mainland made over a large part of the country round the bay to Colonel Nicolls, and in 1848 he agreed to abolish human sacrifices at the funerals of his great men. In 1858 a settlement was made on the coast at the mouth of a small river, flowing into Morton Cove, now known as the Victoria River. The settlers were Mr Saker, a Baptist missionary, and his converts, who removed from Fernando Po, when the Spanish authorities published an edict forbidding public worship to be celebrated by any but the Roman Catholic clergy. To the south-east of the mountains flows the Cameroons River, where the Baptist mission has had a station since 1850. The most important tribe is the Duallas, whose language has been reduced to writing within recent years. The ascent of the Cameroons Mountains was first attempted by Mr Merrick in 1847; but it was not till 1861 that the summit was actually gained by Captain Richard Burton and Mr Mann, a botanist. See Burton's *Abeokuta and the Cameroons Mountains*, 1863; papers by Mr Mann in the *Proceedings of the Linnæan Society*; also *Zeitschrift d. Gesellschaft für Erdk. zu Berlin*, 1874, and Petermann's *Mittheil.*, 1863.

CAMILLUS and CAMILLA, in Roman Antiquity, the title applied to the boys and girls who were occupied in the ceremonies of sacrifice, whether temporarily or as a preparation for their entering the priesthood. In the latter case it was necessary that they should be the children of parents still alive (*patrimi et matrimi*) and freeborn. The name Camillus has been identified with the Cadmilus or Casmilus of the Samothracian mysteries.

CAMILLUS, Marcus Furius, one of the most illustrious heroes of the Roman republic. He triumphed four times, was five times dictator, and was honoured with the appellation of Second Founder of Rome. When accused of having unfairly distributed the spoil taken at Veii, he anticipated judgment, and went voluntarily into exile at Ardea. But during his exile, instead of rejoicing at the devastation of Rome by the Gauls, he exerted himself to repel the enemy, and yet kept with the utmost strictness the sacred law of Rome, in refusing to accept the command, which was offered him by several private persons. The Romans, when besieged in the Capitol by the Gauls, created him dictator; and in this capacity he acted with so much bravery and conduct, that he entirely drove the enemy out of the territories of the commonwealth. He died of the plague in the eighty-first year of his age, 365 B.C. The famous story of Camillus and the schoolmaster belongs to the campaign against the Faliscans in 394. It is said that when Camillus appeared before Falerii, a schoolmaster attempted to betray the town by bringing into his camp the sons of some of the principal inhabitants of the place. Camillus, indignant at such baseness, ordered that the traitor should have his hands tied behind him, and be whipped into the town by his own scholars. It is said that the Faliscans were so affected by the generosity of the Roman general that they immediately surrendered (Livy; Plutarch). For a critical estimate of the remnant of historic truth that lies under the somewhat amplified legendary history of Camillus see Roman History.

CAMISARDS was the name given to the peasantry of the Cévennes who, from 1702 to 1705 and for some years afterwards, carried on an organized military resistance to the *dragonnades*, or conversion by torture, death, and confiscation of property, by which, in the Huguenot districts of France, the revocation of the Edict of Nantes was attempted to be enforced. Court de Gébelin derives the word from *camisade*, a night attack (*Hist. des troubles des Cévennes*, 3 vols. 1760). Louvreleuil, in his *Le Fanatisme Renouvelé*, 1704, suggests its connection with the *camise*, or linen shirt, at one time worn by the insurgents as a uniform, and with *camis*, a road-runner. The Camisards were also called Barbets (or water-dogs, a term also applied to the Vaudois), Vagabonds, Assemblers (*assemblée* was the name given to the meeting or conventicle of Huguenots), Fanatics, and the Children of God. They belonged to that romance-speaking people of Gothic descent who took part in the earliest movements towards religious reform. It was in Languedoc that the Peace of God and the Truce of God were formed in the 11th century against the miseries of private war (Rudolph Glaber, iv. 5). There were preserved the forms of municipal freedom which nearly all Europe had lost; and there commerce flourished without spoiling the thrift, the patience, the simplicity of the national character Not even the voluptuous court of Arles, with its trouvères, its courts of love, and its extravagant applications of the rules of chivalry, could corrupt the free and honest intelligence of these southern communities. Before the tragedy of the Albigenses began, it was a proverb in Languedoc against the stupid and sensual priesthood, "J'aimerais mieux être prêtre que d'avoir fait une telle chose." Although the rage of the Crusaders and the cold hate of the Dominicans were successful in blasting the commercial development of the district, they could not wholly eradicate those ideas which, whether called Paulician, Catharist, Bulgarian, Hussite, or Protestant, really represent religious sincerity and mental freedom. Calvin was warmly welcomed when he preached at Nîmes, Montpellier became the chief centre for the instruction of the Huguenot youth. But it was in the great triangular plateau of mountain called the Cévennes that, among the small farmers, the cloth and silk weavers, and vine dressers, Protestantism was most intense and universal. These people were and still are very poor, but they are intelligent and pious, and they add to the deep fervour of the Provençal character a gravity which is probably the result of their recorded history. From the lists of Huguenots sent from Languedoc to the galleys (1684 to 1762), we gather that the common type of *physique* is "belle taille, cheveux bruns, visage ovale." The diocese of Meude consists of 173 parishes, and contains the Bas Gévaudan and the Haut Gévaudan. The Haut Gévaudan consists of the Mountains la Marguerite and Aulrac; the Bas Gévaudan embraces the Hautes Cévennes and the Lozère. In the midst of these mountains are three great plains or plateaux, called respectively L'Hôpital, L'Hospitalet, and La Cause, and a forest named Le Faux des Armes. Barley and chestnuts are the chief products of Gévaudan. The Basses Cévennes are in the richer diocese of Alais, which has 93 parishes. The chief mountains are Aigoal and Esperon, the latter enclosing a beautiful plateau named Hort-Dieu (God's Garden). The Vivarais lies in the diocese of Viviers, which has 314 parishes and 3 cantons; Boutières, Montagne, and Bas-Vivarais. Farther south are the well-cultivated dioceses of Uzes, Nîmes (called Little Canaan), and Montpellier, the last of which is connected with La Serrane, the southern branch of the Cévennes. The whole district of the war is thus contained in the modern departments of Lozere, Aveyron, Drôme, Ardèche, Gard, and Hérault.

To understand the war of these Camisards requires a glance at the preceding history of France. The system of toleration which was established under the Edict of Nantes, 13th April 1598, and the Edict of Grace (Nimes), July 1629, was essentially a political compromise, and not a recognition of the principle of religious equality. The right of having a private chapel was given to all *seigneurs de fief haut justicier*, but in the case of a *seigneur sans haute justice* only thirty persons might attend the service. New public churches were to be authorized at a certain rate in certain places. On the other hand, Calvinists were admitted to all public posts and to all professions: they could publish books in towns where they had churches. The Chamber of the Edict was formed in the parliament of Paris for the impartial judgment of cases brought by Huguenots; and the "mi-partie," half-Catholic half-Protestant constitution, was adopted in the town-consulates and the local parliaments of the south. After the short-lived struggle between Louis XIII. and the Duc de Rohan, the Huguenots settled down into contented industry; the army and navy of France were led by two Huguenots, Turenne and Duquesne, and Cardinal Bentivoglio wrote to Pope Paul IV. that he no longer found in France "quell' insano fervor di coscienza si radicato primo negli ugonotti." But the court in which Mme. de Maintenon had succeeded to Mme. de Montespan, where Louvois and the Jesuit Père la Chaise were as supreme as Bossuet and Fléchier in the church, could not long be satisfied with tolerated heresy, which they chose to consider as veiled rebellion.

On the death of Mazarin a commissioner had perambulated the kingdom to inquire into the titles, or rather to suppress as many as possible, of the Huguenot churches, schools, and cemeteries. The extirpation of heresy had, in fact, been provided for by a clause in the marriage-contract between Louis and Maria Theresa (1660), and in spite of the protection of Colbert, a policy was begun of destroying piece-meal the privileges of the dissenters. The chancellor Le Tellier, by a series of arbitrary council edicts, shut against them the public offices and the trade corporations, forbade them to marry with Catholics, and encouraged, almost enforced, the conversion of children who had reached the age of seven. The wholesale briberies of Pélisson, the destruction of churches by Foucault in Montauban, Béarn, and Poitiers, the billeting of soldiers on the unconverted in Languedoc by the intendant Bâville, led up the Edict of Revocation (18th October 1685). This edict directed all the churches to be destroyed, forbade religious meetings under pain of imprisonment and confiscation of goods, ordered all ministers or pastors (who would not change their faith) to be banished within fifteen days, and to stop preaching at once under pain of the galleys, promised several exemptions from taxes and increased salaries to converted ministers, suppressed all Huguenot schools, and directed all children to be baptized and brought up in the Catholic faith, prohibited all Huguenots, except ministers, from going abroad, and declared the property of those who had already gone to be forfeited unless they returned within four months. Such was the formal scheme. In carrying it into effect, Huguenot Bibles, Testaments, Psalters, and books of religious instruction were burned, and Huguenots were forbidden to hire themselves as artisans or as domestic servants. Torture, hanging, insults worse than death to women, the galleys for life, imprisonment for life in the Tour de la Constance, near Aigues-mortes, were the ordinary occurrences of the next sixty years. Many escaped to Geneva, Lausanne, Amsterdam, and London. It is calculated that 600,000 French Protestants left their country in the twenty years following the revocation, and 400,000 in the twenty years preceding it (Smiles, *The Huguenots in France*, p. 17). Many suffered a shameful

conversion, but in the Cévennes the inhabitants were too poor to escape, and all over Languedoc began the secret meetings of the Church of the Desert. At last Louvois proposed that this rebellious district should be turned into an actual desert. The intendant Bâville and the Duc de Noailles raised an army 40,000 strong, and erected forts at Nîmes, St Hippolyte, Alais, and Anduze. The peace of Ryswick (1697) facilitated these operations. The religious hysteria which now descended on the Cévennes has been traced (*De l'Inspiration des Camisards*, par Hippolyte Blanc, Paris, 1859) to Du Serre, an old Calvinist of Dieu-le-fit, who, in reading Jurieu's well-known book on the *Fulfilment of the Prophecies*, became suddenly inspired to preach and pray, and who about 1689 communicated his enthusiasm to the shepherdess La Belle Isabeau, and 500 or 600 other so-called prophets.

In 1700 this sacred fire again broke out in the person of a travelling dressmaker in Ardèche, and spread from the summits of the Lozère to the sea (Peyrat, *Histoire des Pasteurs du Désert*, i. 261). A woman (Isabel Vincent) was again the most exalted of the prophets. The Abbé du Chaila, a veteran Catholic missionary from Siam, had been appointed inspector of missions in the Cévennes. There he introduced the "squeezers" (which resembled the Scotch "boot"), and his systematic and refined cruelty at last broke the patience of his victims. His murder, on 23d July 1702, at Pont de Mont Vert, was the first blow in the war. It was planned by Esprit Séguier, the "Danton of the Cévennes," who at once began to carry out his idea of a general massacre of the Catholic priests. He soon fell, and was succeeded by Laporte, an old soldier, who, as his troop increased, assumed the title of the Colonel of the Children of God, and named his camp the "Camp of the Eternal." He used to lead his followers to the fight, singing Clement Marot's grand version of the 68th Psalm, "Que Dieu se montre seulement," to the music of Goudimal. Besides La Porte, the forest-ranger Castanet, the wool-carders Conderc and Mazel, the soldiers Catinat, Joany, and Ravenel were selected as captains,—all men whom the *théomanie* or prophetic malady had visited. But the most important figures are those of Roland, who afterwards issued the following extraordinary despatch to the inhabitants of St André :—"Nous, comte et seigneur Roland, généralissime des Protestants de France, nous ordonnons que vous ayez à congédier dans trois jours tous les prêtres et missionaires qui sont chez vous, sous peine d'être brûlés tout vifs, vous et eux" (Court, i. p. 219); and Jean Cavalier, the baker's boy, who, at the age of seventeen, commanded the southern army of the Camisards, and who, after defeating successively Count de Broglie and three French marshals, Montrevel, Berwick, and Villars, made an honourable peace.[1]

Cavalier for nearly three years continued to direct the war. Regular taxes were raised, arsenals were formed in the great limestone caves of the district, the Catholic churches and their decorations were burned, and the clergy driven away Occasionally routed in regular engagements, the Camisards, through their desperate valour, and the rapidity of their movements in a country without good roads, were constantly successful in skirmishes, night attacks, and ambuscades. A force of 60,000 was now in the field against them; among others, the Irish Brigade which had just returned from the persecutions of the Vaudois. Montrevel adopted a policy of extermination, and 466 villages were burned in the Upper Cévennes alone, the population being for the most part put to the sword. The Pope, Clement XI., assisted in this glorious work by issuing a Bull against the "execrable race of the ancient Albigenses," and promising remission of sins to the holy militia which was now formed among the Catholic population, and was called the Florentines, Cadets of the Cross, or White Camisards. Villars, the victor of Hochstadt and Friedlingen, saw that conciliation was necessary; he took advantage of the feeling of horror with which the quiet Protestants of Nîmes and other towns now regarded the war, and published an amnesty. In May 1704 a formal meeting between Cavalier and Villars took place at Nîmes. The result of the interview was that a document entitled *Très humble requête des réformés du Languedoc au Roi* was despatched to the court. The three leading requests for liberty of conscience and the right of assembly outside walled towns, for the liberation of those sentenced to prison or the galleys under the revocation, and for the restitution to the emigrants of their property and civil rights, were all granted,—the first on condition of no churches being built, and the third on condition of an oath of allegiance being taken. The greater part of the Camisard army under Roland, Ravenel, and Joany would not accept the terms which Cavalier had arranged. They insisted that the Edict of Nantes must be restored,—"*point de paix, que nous n'ayons nos temples.*" They continued the war till January 1705, by which time all their leaders were either killed or dispersed.

In 1709 Mazel and Claris, with the aid of two preaching women, Marie Desubas and Elisabeth Catalon, made a serious effort to rekindle revolt in the Vivarais. In 1711 all opposition and all signs of the Reformed religion had disappeared. On 8th March 1715, by medals and a proclamation, Louis XIV. announced the entire extinction of heresy. Fourteen years afterwards, in spite of the strictest surveillance, aided by military occupation whenever the exigencies of foreign war permitted, the heroic missionary Antoine Court had organized 120 churches in Languedoc, which were attended by 200,000 Protestants, and governed secretly by the old discipline of "pasteur, anciens, consistoire, synode;" the Society of Help for the Afflicted Faithful (to which George I. subscribed 500 guineas a year) had established their training college at Lausanne; and during the next thirty years Paul Rabaut, minister at Nîmes, fostered and developed this religion, the child of intolerance. Voltaire's intervention in the affair of Calas stopped further religious persecution of an extreme kind;[2] but it was not till 1775 that the last galley slaves from Languedoc were liberated, and not till 1789 that, on the motion of Rabaut St Étienne, the son of Paul Rabaut, the National Assembly repealed the penal laws against Protestants.[3] The sufferings of the Cévénols on the galleys ("Forçats pour la Foi," as they were called) have been described in the *Mémoires de Marteilhe de Bergerac*, Rotterdam, 1757 (translated into English by J. Willington, 1758, 2 vols.); in Bion's *Relation des tourments que l'on fait souffrir aux Protestants sur les galères de France*, London, 1708; in the *Discours sur la Providence*, by Louis de Marolles, which is translated into English; and in the *Histoire de l'Honnête Criminel*, the autobiography of Jean Fabre. M. Athanase Coquerel the younger published in 1866 an *Historical Study* on the subject.

[1] Cavalier afterwards entered the British army, fought at the battle of Almanza, and died governor of Jersey in 1740. He told Voltaire that the discipline of his troops was maintained by a prophetess, La Grande Marie, who condemned to death all insubordinates. *Siècle de Louis XIV.*, c. 36. See also *Memoirs of the Wars of the Cévennes*, by Jean Cavalier, London, 1726; and the documents in *Jean Cavalier, ou les Fanatiques des Cévennes*, Paris, 1840, 4 vols.

[2] Voltaire procured the release of several Huguenot galley slaves, among others Chaumont, the shoemaker. After the treaty of Utrecht Queen Anne persuaded the French Government to free about 146; the total number was about 1500.

[3] There was an indecisive Edict of Toleration by Louis XVI. in 1787.

What we know of the spiritual manifestations in the Cévennes (which much resembled those of the Swedish Raestars of Smaland in 1844) is chiefly derived from *Le Théâtre Sacré des Cévennes*, London, 1707, reprinted at Paris in 1847; *A Cry from the Desert*, &c., by John Lacy, London, 1707; *La clef des prophéties de M. Marion*, London, 1707; *Avertissements prophétiques d'Elie Marion*, &c., London, 1707 About the date of these publications Marion, Durand Fage, and Cavalier were in London. They tried to propagate their "mystical phalanx" there, but the consistory of the French church in the Savoy pronounced the "ecstasy" to be an assumed and voluntary habit. Voltaire relates (*Siècle de Louis XIV.*, c. 36) that Marion wished to prove his inspiration by attempting to raise a dead body from St Paul's churchyard. He was at last compelled to leave England. The inspiration (of which there were four degrees, *avertissement, souffle, prophétie, dons*) was sometimes communicated by a kiss at the assembly. The patient, who had gone through several fasts three days in length, became pale and fell insensible to the ground. Then came violent agitations of the limbs and head, as Voltaire remarks, "quite according to the ancient custom of all nations, and the rules of madness transmitted from age to age" Finally the patient (who might be a little child, a woman, a half-witted person) began to speak in the good French of the Huguenot Bible words such as these: "Mes frères, amendez-vous, faites pénitence, la fin du monde approche; le jugement général sera dans trois mois; répentez-vous du grand péché que vous avez commis d'aller à la messe; c'est le Saint-Esprit qui parle par ma bouche" (*Histoire du fanatisme de notre temps*, par Brueys, Utrecht, 1737, vol. i. p. 153). The discourse might go on for two hours; after which the patient could only express himself in his native patois,—a Romance idiom,—and had no recollection of his "ecstasy." All kinds of miracles attended on the Camisards. Lights in the sky guided them to places of safety, voices sang encouragement to them, shots and wounds were often harmless. Those entranced fell from trees without hurting themselves; they shed tears of blood; and they subsisted without food or speech for nine days. The supernatural was part of their life. Much literature has been devoted to the discussion of these marvels. The Catholics Fléchier (in his *Lettres Choisies*) and Brueys consider them the product of fasting and vanity, nourished on apocalyptic literature. The doctors Bertrand (in his *Du Magnetisme Animal*, Paris, 1826) and Calmeil (in his *De la Folie*, Paris, 1845) speak of magnetism, hysteria, and epilepsy, a prophetic monomania based on belief in divine possession. The Protestants Peyrat and Court are content with the phrase "ecstasy," and do not invoke the supernatural. The Catholic Tories, such as M. Hippolyte Blanc, regard the whole thing as the work of the devil. Since the publication of Hecker's work on *Epidemics of the Middle Ages*, it has been possible to consider the subject in its true relations.

Although the Camisards were guilty of great cruelties in the prosecution of the war, there does not seem to be sufficient ground for the charge made by Marshal de Villars: "Le plupart de leurs chefs ont leurs demoiselles" (letter of 9th August 1704, in the *War Archives*, vol. 1797). There probably were many cases in which a vicious use was made of the opportunities afforded by war and religious excitement; but the charges of sexual immorality rest chiefly on the worthless statements of Louvreleuil. The standard works relating to the Camisards are,—Elie Bénoît, *Historie de l'Édit de Nantes;* C. Coquerel, *Histoire des Églises du Desert;* and the work of Court, already mentioned.

Among the contemporary relics of this interesting period ought to be noticed *Lettre sur l'État present des Églises réformées de France*, Au Desert, Chez Pierre le Sincère. The author proves from the letter of Louis XIV. to the Elector of Brandenburg, 6th September 1666, that the king admitted that the Huguenots were loyal subjects, and had even given remarkable proofs of loyalty. He contrasts the passivity of his friends with the political intrigues of the Polish Socinians, and with the turbulence of the Swiss Anabaptists. Claude, in his *Plainte des Protestans cruellement opprimés dans le Royaume de France*, Cologne, Chez Marteau, 1686, gives a vivid picture of the persecution from the beginning. He mentions the "Explications," or official glosses on the edicts, of which the Jesuit Meynier was the most prolific author, one of which maintained that the Edict of Nantes (contrary to its express terms) was confined to Huguenots in life at its date; another, that the phrase *Petite École* did not include any school in which Latin was taught. He inveighs against the duplicity of the *Conseil*, who professed sometimes to blame, sometimes to encourage their intendants, and of the king, who in his circulars to the clergy declared (down to the moment of revocation) that he did not wish to interfere with the edicts. Soulier in his *History of the Edicts of Pacification*, and Nicole in his *Protestants convicted of Schism*, justified the royal policy from Scripture, history, and reason. Maimbourg in his *History of Pope Gregory*, and Varillas in his *History of Religious Revolutions in Europe*, praise Louis for using only the weapons of charity and persuasion. Translations of the narratives of John Bion, and of the anonymous friend of the martyr Louis de Marolles, were published together at London in 1712. The latter is dedicated to Heinsius, Pensionary of Holland and West Friesland, who had assisted the refugee Camisards; it is preceded by a violent preface, in which the author, an English clergyman, points out how the position of France has altered since the Peace of Ryswick, and urges the English intervention to restore the Edict of Nantes. For the politics of the subject he refers to *The Interest of Europe with respect to Peace or War*, London, 1712. Bion's narrative contains all the details about the galleys. *The Complete History of the Cevennes by a Doctor of the Civil Law*, London, 1703, consists of an account of the people and country by an Englishman who had lately travelled there, and of a separate historical survey, description of the edicts, and political argument. The doctor also prints the pretended *Manifesto of the Cevennois to the Dauphin*, and a form of prayer used in the Camisard Assembly. *The Memoirs of Jean Cavalier* are written in a very simple and picturesque style. One object he had in writing was to contradict the statements of Père Daniel. The *Théâtre Sacré des Cevennes* consists of the depositions of twelve witnesses (including Marion, Fage, Cavalier, Portales, Dubois) sworn on 6th March and 1st April 1707, before John Edisbury and Sir Richard Holford, both Masters in Chancery. The *Théâtre* also contains important extracts from the works of Bénoît, Brueys, Guiscard, and Boyer, and several original letters from Camisards. The same desire to protect the refugees from the attacks of the French Savoy Church in London, led to the publication of the *Mélange de litterature historique et critique sur tout ce qui regarde l'état extraordinaire des Cevennois*, London, 1707; and of a full account of the proceedings in the Consistory and Assembly against Jean Lions, one of the faithful ministers. The former contains excerpts from a *Dissertatio de justitia armorum Cebennorum* by Ernest Plane, Frankfort, 1704, which speculates about a supposed Camisard medal, turning out afterwards to be a Swedish dollar; the letters C R S (which the German savant translated Christus Rex Solus) meaning only Carolus Rex Sueciæ. (W. C. S.)

CAMOENS (or, according to the Portuguese spelling, CAMÕES), LUIZ DE (1524–1579), the son of Simão Vaz de Camoens and Ana de Sá e Miranda, was descended in the female line from the Gamas of Algarve, with which family Vasco de Gama claimed kinship; on the male side also the Camoens were of gentle birth and high social position. Lisbon, Coimbra, Alemquer, and Santarem have claimed to be the cradle of this "prince of poets of his time;" the balance of evidence, however, is now generally considered to be in favour of Lisbon. Manoel Correia, who was on terms of intimacy with the poet, in his *Commentaries on the Lusiad*, states: "The author of this book is Luiz de Camoens, Portuguese by nationality, born and bred in the city of Lisbon, of noble and accredited parentage." Correia states in his notes to canto 10 of the *Lusiad*, that Camoens was more than forty years of age when he wrote it; and, further on, that the canto was written in 1570. The evidence of Faria e Sousa, extracted in 1643 from the registers of the "India House at Lisbon," proves Camoens to have been twenty-five years of age in 1550; and 1524 is now generally accepted as approximately the year of his birth.

Alarmed by the shock of an earthquake as early as 1526, the court removed to Coimbra, where it remained until the pestilence, which devastated Lisbon and the border lands of the Tagus, had moderated; the nobles and "fidalguia" followed the king and court. Simão Vaz de Camoens having house and possessions at Coimbra, would naturally follow the court there with his family; the more so as his brother Bento had, prior to 1527, taken "the habit in the monastery of Santa Cruz," where he was often visited by the king. Evidently a man of culture, he was chosen, on the reformation of the university in 1529, "being then prior of his order," the first chancellor. The popularity of the training at the newly-reformed university drew within its walls most of the sons of the nobility and "fidalguia." Here Camoens was entered as one of "the honourable poor students" in 1537, remaining there until he had completed his eighteenth year. Of his manner of life during the period which intervened between his removal to Coimbra and the commencement of his university career, something may be gathered from his minor writings, from which it appears that he wandered by Mondego's banks, "careless and unfettered in the free licence of boyhood."

The position of the poet's uncle, Dom Bento de Camoens, as prior of Santa Cruz, in addition to his status as chancellor of the university, naturally suggested the church as a career for Camoens. This seems to have found no favour with him, as he writes, "I felt the pulse of many states of life. The clergy, I see, take stronger hold of life than of the salvation of souls; and the monks, although shrouded in hood and habit, expose some small tokens inconsistent with the profession that he who turns his back upon the world for God should desire nothing that the world can give." Freely and injudiciously expressed at an inopportune moment in the ardour of youth, such home truths would tend to mar his advancement in church or state; while his honesty, culture, wit, poetic genius, and comely appearance would induce much jealous enmity at a court where he was the idol of the women.

During his studentship, and possibly at a vacation revel, or when some degree was conferred, the students acted his *Amphitriões* in imitation of Plautus. The dramatic representations at the university had usually been of the tragedies of Seneca, or of original Latin compositions. This work of Camoens, in popular "redondilhos," and in the vernacular, was considered an attempt to popularize a poetic reaction which satirized the mode in which the grave doctors of the university desired that all instruction should be imparted. In a satire of Resende's, "to Luiz Camoens, reprehending those who, despising the learned, waste their own time with jesters," he indicates Camoens "as a pitiful poet, an unlucky monster, boasting to be a Latin bachelor."

With reference to the precise period when Camoens removed entirely from his *alma mater* and became again resident in Lisbon, some speculations have been hazarded by his biographers. The one carrying the most weight is cited by the Visconde de Juromenha, who founds it upon the statement made by the poet in his first letter from India: "Because, when I reflect that without sin, which would sentence me to thirteen days of purgatory, I have passed thirteen thousand caused by evil tongues." Upon this Juromenha observes: "These thirteen thousand days are equal to eight years and eight days, and deducting the two years Camoens passed in Ceuta, and the one year of banishment on the upper Tagus, this leaves 1542 as the year of his departure from Coimbra." Thus we find Camoens quitting college to return to the court at Lisbon in his eighteenth year. A French biographer has assumed, with some force, that "Corte" simply means Lisbon, and not the court; for as Camoens was not of the titular nobility, he would not be received at court. Contemporary evidence, on the other hand, rather favours the assumption that being of the "fidalguia," gentle born, and well cultured, he would be chosen as companion by many of the young nobles who were his fellow-students at Coimbra.

Gentleness of birth, classical attainments of no mean order, a cultivated intellect, and poetic genius, united to a pleasing personal appearance and witty manner, must have been good passports to the court of John III., in which resided at that time the Infante Dom Luiz, a man of considerable attainments and a fair poet; also the Infanta Donna Maria, patroness of the Belles Lettres, surrounded by a bevy of fair damsels who could compose song, dirge, epigram, and roundelay, or jest with the quick wit of a Beatrice, and who, like her, knew many "merry tales" by heart. Statesmen, such as the Conde de Sortelha and the Conde de Vimioso, courtly poets, and fellow-students of Camoens at Coimbra, both in the full blaze of court favour, would gladly welcome to Lisbon so polished a youth as Camoens must at that time have been. Of this same court of John III. Gil Vicente writes, "It is a sea in which many fished, but found the pastime dangerous." Sá de Miranda also blamed "the economic error of herding together all the young nobility in Lisbon."

Here, no doubt, Camoens formed acquaintanceships if not friendships, and became quickly initiated into the mysteries of court life and manners. Precocious and born a poet, his facility in every style of versification, a mind stored with romances of chivalry as well as popular fiction, and the poetic lore then available in his own, the Spanish, Italian, and classical idioms, would, added to his youth and sprightly manner, render him popular with the gentler, and unpopular with the sterner sex. Abandoning in some degree the antiquated forms of composition in vogue, he introduced eclogues, songs, and sonnets, full of tenderness and beauty, after the manner of the Italian school. Montemayor and Sá de Miranda, both Portuguese, residing in Italy, had already adopted and naturalized to some extent the Italian form of pastoral poetry.

Here we must speak of Camoens's romantic passion for a certain high-born lady of the court. "The sweet unwitting cause" of so much detriment to his court advancement, and, if we are to credit his muse, of anguish to his heart, was a certain Donna Caterina de Ataíde in attendance upon the queen of John III. The anagram of Natercia for Caterina clearly indicates the lady's name, in addition to which an acrostic coupling the names of Luiz with Caterina de Ataíde, said to be by Camoens, puts the matter beyond all doubt. The tradition is that, on a certain Good Friday, Camoens for the first time encountered the lady's eyes at her devotions in the Church of the Chagas, Lisbon. That the wound proved deep and permanent there is abundant evidence in his *Rimas*.

The lady's father, Dom Antonio de Lima, held the office of chamberlain in the royal household, a certain Pero de Andrade de Caminha serving in a similar capacity the Infante Dom Duarte. Caminha was a poet of fair ability, and was probably jealous of the success of Camoens; in addition to which tradition asserts that Caminha himself, favoured by her father, aspired to the hand, if not the heart, of the Donna Caterina. We may infer that the lady was not ignorant of the effect her eyes wrought upon the author of the *Lusiad*; at any rate Caminha was jealous, and revenged himself in weak splenetic rather than satirical verse, while the lady's father employed his interest to mar the poet's prospects.

The precise cause which led to Camoens's banishment from Lisbon is not clear. The principal reason, no doubt, was his passion for the golden-tressed Caterina, but there

may have been in addition to this some unintentional contempt of the rigid court etiquette which hedged the royalty of that day; for it was the custom that lyric offerings intended for the ladies of the queen's court should first be submitted to the chamberlain, and then by him transferred to the chief lady in waiting, who handed the effusion to the queen,—she, in her turn, after perusal, passing the "burning lines of passion" into the hands of the damsel to whom they were addressed. Camoens, doubtless, would essay some safer and more secret mode of conveying his offerings to the lovely Caterina. The dislike of De Lima, and the jealousy of Caminha, aided by the indiscretion and free-lance life of Camoens, may have led to this mark of the royal severity. Whether such or other causes intervened, the fact remains that he was banished from the court. The precise locality to which he retired, however, still remains conjectural only. Adding the year of his banishment to the two years he was absent with the army of Africa at Ceuta, where, in a naval engagement with the Moors, a chance splinter destroyed the sight of his right eye, we find him again in Lisbon in 1550.

During the three years which intervened between Camoens's return from Ceuta and his embarkation for India in 1553, he seems to have led a careless and discreditable kind of life, consorting with the least reputable court gallants, and a certain dissolute ex-Franciscan friar, who had abandoned the cowl to adopt the *rôle* of a low comedian. Since he inherited the traditions of "fidalguia,"—candid, brave, impetuous, and crossed in love,—much of the free and careless life credited by tradition at this period to Camoens is reasonably accounted for, if it may not be condoned. At this period occurred the fracas which led to his imprisonment and subsequent embarkation for India. On the occasion of a grand procession at the festival of Corpus Christi, one of the king's equerries appears to have had a dispute with two masquerading companions of Camoens. The latter, unhappily intervening to defend one of these friends hardly pressed, wounded the equerry in the neck, his two friends escaping in the confusion. For this Camoens lay some time in prison, and was only pardoned upon the understanding that he should embark forthwith for India. Juromenha gives the full text of this pardon.

With reference to the poet's departure for India in March 1553, the indefatigable Faria e Sousa discovered the following entry on the books of the registry of the Lisbon India House:—"Fernando Casado, inhabitant of Lisbon, went in his stead Luiz de Camoens, son of Simon and Ana de Sá." His father did not offer himself as the customary surety, while it is seen from a document, dated the 7th of March that year, that he was still alive, and an inhabitant of Lisbon.

Camoens, in his first letter from India, alludes to his departure from his native city; and as he sailed out of the "golden-sanded Tagus" in the twilight, exclaimed in the bitterness of his heart, using the words of Scipio Africanus,—"Ungrateful country, thou shalt not possess my bones!"

The ship in which he sailed, the "San Bento," parted company with her consorts during a storm, and reached her destination in the same year, while her missing consorts did not anchor at Goa until the following spring. On landing at Goa, Camoens found the Viceroy Noronha preparing an expedition to act against the king of Pimenta, who had invaded the territories of the allies of Portugal. With this expedition sailed Camoens; and "after chastising the enemy," he says, "with little trouble, we destroyed the people trained to the use of the curved bow, punishing them with death and fire." He returned to Goa early in the following year, 1554.

The friendly terms upon which Camoens remained with the governor, and probably his disgust at the vice and venality rampant around him, induced him to join the expedition organized with a view to check the depredations of the Moorish rovers on the coast of Arabia. The commander, Menezes, received instructions to cruise on that coast where he expected to intercept the galleys sailing from Bassorah. The fleet cleared from Goa early in the year 1555; and, after seeking the Moorish galleys in vain, wintered at Ormuz. Returning in the following spring to Goa, Camoens, in canção 10, describes his unpleasant impressions of this voyage: "Here fate's most cruel chances led me; here in this lonely, sterile, sun-scorched land did Fortune will that part of my brief life be passed, and thus in fragments scattered lie throughout the world." Some of Camoens's biographers allude to the governor Barreto as one of his relentless persecutors. Juromenha, however, demurs to this, alleging that two intimate friends of Camoens then at Goa, in the most frank and decided language, laud Barreto as "a liberal obliging comrade, and one ever ready to overlook offences received." That Camoens was unpopular with the venal many, his expression "This land is the mother of great villains and the stepmother of honourable men" leaves little doubt. He came to uphold the honour of Portugal, and not to intrigue, brawl, and barter his soul for gold. His satirical exposure of the abuses so rife then in the Eastern dominions of Portugal will readily account for his numerous enemies, official and lay. Festivals, banquets, and dramatic representations inaugurated the governorship of Barreto. Camoens's pen was not idle. He wrote a comedy for the occasion, entitled *Filodemo*. Correia, who describes himself as "companion in the state of India, and a great friend of Camoens," happily secured either the original MS. or a copy, which is, or was, in the national library at Lisbon. It is entitled, *A Comedy made by Luis de Camoens, and represented in India during the governorship of Barreto, and in which the following characters figure, &c.*

Camoens's unpropitious star still dominated his fate. The vices rampant in Goa, the drunkenness, dicing, brawling, and cowardice, were notorious; and during these festivities, which lasted some weeks, were more pronounced than ever.

A certain satire, said to be from the pen of Camoens, passed from hand to hand, entitled *A Jest which was made upon some men who did not think ill of wine, feigning that in Goa, at the feasts which were made on the governor's succession, these gallants went to sport with canes bearing devices on their banners, and verses conforming to their designs and inclinations.* It is written chiefly in prose, having verses introduced. No names of the "gallants" appear. After introducing a few of these revellers, the author concludes by stating "that several other illustrious personages desired to be admitted to the feasts and sports, and to have an account of their qualifications chronicled;" but, he observes, "the writing would be infinite, because all the men in India are so distinguished, and therefore let these suffice as examples." This jest, intended to satirize the corruption and immorality of the daily life of the Portuguese in India, caused intense amusement to those who did not recognize their own portraits on the canvas; while, on the other hand, those who did, or imagined they did, were furious,—so much so, that "the innocent author remained ready to hang himself."

The tradition is that this *Jest* was appended to Camoens's second letter from India, and that the author desired its source should remain unknown; "because I do not wish that of my little so many should eat." Be that as it may, Camoens was banished from Goa, and this *Jest* is said to have been the cause. Some of those ridiculed

were powerful, malignant, and treacherous; and it is surmised that Barreto was of the number, but it is difficult to imagine that if Barreto intended punishment he should have made of this banishment a stepping-stone to a lucrative appointment, which must have been one of considerable importance, embracing as it did the custody of the property of absentees, and of those Portuguese who had died in India. In a letter from Francisco de Souza to John III. the importance of this office is recognized, grave complaints of embezzlement and misappropriation of the property of deceased merchants and others having reached Lisbon, so that, "early in 1556, a commission was despatched from the mother country to take charge of the effects of deceased subjects," and, in 1557, "full instructions as to the management of this state department followed." Barreto, with a laudable desire to abate these scandals, may well have appointed a bold energetic man, upon whose integrity he could rely, and Camoens was selected.

During the absence of Camoens from Goa his friend Luiz Franco Correia collected the verses he had scattered amongst his friends, shrewdly observing, "that they who knew not the poetic art failed to estimate its value."

Apart from the vices and intrigues of Goa, and in the quietude of the Grotto still shown at Macao as the spot where much of the *Lusiad* was penned, we may imagine halcyon days for the persecuted poet. Here Antonio, the Javanese slave, is first introduced to history,—he who tended Camoens so affectionately and with such solicitude through those latter years of misery and neglect, which were the lot of this unhappy "prince of poets of his time." It is surmised that the first six cantos of the *Lusiad* were composed during Camoens's stay at Macao; for in the seventh, allusion is made to the shipwreck he suffered on his return to Goa.

During his absence slanderous tongues were not silent, and we hear of his return to Goa by order of the governor, to make answer to charges brought against him in his capacity as commissary. Wrecked near the mouth of the River Mekong, Camoens and his faithful Javanese escaped only with their lives. Camoens, rescuing nothing but the manuscript of his epic, at length landed at Goa in the last days of Barreto's governorship, and was cast into prison. Here he received the only news which could aggravate his pain—the sad tidings of the death of Donna Caterina de Ataide, the Natercia of his impassioned youth. We can estimate the depth and tenderness of his grief touchingly expressed in many of the *Rimas*.

The arrival in the autumn of the following year of Dom Constantinho de Bragança as governor to replace Barreto led to the liberation of Camoens, the charges against him having been proved to be unfounded. Under the protection of Dom Constantinho the poet enjoyed some respite from his persecutors. It was during this period of "cultured calm" that he invited several "versifying friends" to a banquet, where each, on uncovering his plate, discovered, in place of the first course, an appropriate stanza. The surprise gave occasion to considerable mirth and amusement. Three years later Dom Constantinho was replaced by the Conde de Redondo, an early friend and companion of the poet's. Towards the close of 1562 Camoens suffered a new reverse. Miguel Rodriguez Coutinho, a rich braggart, nick-named Fios Seccos (dry threads), detained him in custody for a trifling debt. On this occasion Camoens sent a request to the Conde to release him, in epigrammatic verse, which well revenges Coutinho's meanness, commencing—"What devil so completely damned but fears the edge of Fios Seccos' sword." Camoens was released, but does not appear to have accompanied the viceroy and his splendid retinue to Zamorin. Being desirous to return to his native land, a certain Captain Barreto, nephew of the old governor of Goa, charmed with the society of the poet, agreed to carry him to Sofala; once there he hoped to detain him, and claimed a small sum he was unable to discharge. Here the expedition under Noronha, ex-governor of Goa, found him; and of Camoens's condition Diogo de Couto wrote: "Here we encountered that 'prince of poets of his time,' my fellow-sailor and friend, Luiz de Camoens, so poor that he lived upon his acquaintance, who found him necessary clothing and gladly gave him to eat. During that winter he prepared his *Lusiad* for the press, and wrote much in a book he called the *Parnaso of Luiz de Camoens.*"

The fleet, including the "Santa Clara," with Camoens on board, sailed from Sofala in November 1569, and on the 7th April 1570 the good ship cast anchor in the broad waters of the "golden-sanded Tagus."

After seventeen years of weary exile we may imagine the thrill of joy that warmed the heart of Camoens at the first sight of the headland which bares its base to the wash of the Atlantic, and marks the entrance to the Tagus. "From the round-top of the loftiest mast a sailor shouts, 'The land, the land!' This is my native land so fondly loved, which heaven grant, all perils past, my task accomplished, these eyes behold once more before their light be dimmed for ever." While others from the far Indies brought rich merchandize and gold, he who had suffered banishments and imprisonments, had encountered tempests and shipwreck, came freighted only with a single manuscript, on the pages of which were traced in immortal verse the glorious historic deeds of the Portuguese nation, and the touching episode of Ignez de Castro. Here Fortune still continued to persecute Camoens. He and his companions were not permitted to land, Lisbon having recently suffered from the effects of a pestilence which had destroyed 50,000 souls.[1]

Late in the month of April, the great plague having abated, a procession of our Lady of Health was decreed; and it is supposed that Camoens had already landed and embraced his mother, then "very old and very poor." The *Lusiad*, being now completed and ready for the press, after much delay and many impediments, was, through the influence of Dom Manoel, ambassador to Castile, presented in manuscript to the young king in the following year, 1571; the royal permission to print the work was accorded, the Alvará bearing date the 23d September of that year. Later the "censura" of the holy office was obtained, bearing date 12th March 1572. It carries the signature of Father Ferreira, a man of singular ability and evidently liberal views, and is as follows:—"I saw, by order of the Holy Inquisition, these ten cantos of the *Lusiad* of Luiz de Camoens, relating the valorous deeds in arms of the Portuguese in Asia and Europe, and I did not find in them a single offensive thing, nor aught contrary to the faith and good manners; only it seemed to me necessary to warn the reader that the author, in order to exaggerate the perils of the navigation and entrance into India of the Portuguese, makes use of a fiction of the heathen gods; and although San Agostinho in his *Retractações* corrects the having called the muses goddesses, nevertheless, as this is poetry and fiction, and the author does not pretend more than to adorn his poetic style, I have not considered it inconvenient this fable of the gods in this work, knowing it for such, and while is always preserved the truth of our Holy Faith, that all the gods of the heathen are devils, and therefore it appeared to me that the book is worthy of being printed.

[1] No record has been discovered of the death of Simão Vaz, father of the poet, but it is conjectured that he died of the plague during the autumn of 1569.

and the author displays in it much talent and erudition in the human sciences." The Lisbon upon which Camoens turned his back in 1553 had sadly changed; the times were out of joint. A dreadful pestilence had decimated the population; the intrigues inseparable from a regency, and a young king, the sport of youthful favourites, ruled by the Jesuits, brave and impetuous, already meditating the luckless expedition to Africa, overshadowed both court and kingdom. Remarking this, in his address to the young king Camoens wrote,—"The humility of the anchorite should not be the only virtue of your ministers."

At length the epic, dreamed of at Coimbra, commenced in banishment, continued at Ceuta, resumed at Goa and Macao, revised at Mozambique and Sofala, and perfected in a humble room in the Rua de Santa Ana, Lisbon, was issued from the press of Antonio Gõçalvez.

The first edition of the *Lusiad* bears date Lisbon, 1572. Its success was immense, and the despair and malice of the mediocre poets of the court intense. A second edition was issued from the press of Gõçalvez in the same year.

Isolated amid this literary strife, Camoens lived retired, and was very poor. He lived in the knowledge of many, and in the companionship of few, inhabiting an apartment in a house adjoining the convent Santa Ana, at the bottom of a small street which led to the college of the Jesuits, where the sole consolation of his later years was his intimacy with some of the fathers. By the death of the Princess Donna Maria, who expired in 1578, Camoens lost the last of his protectors, and was reduced to extreme poverty; then came the heaviest blow of all, the death of his faithful Javanese Antonio.

Early in the year 1578, after the grand ceremony of the Benediction of the Standards, Dom Sebastião, the boy king, departed on his ill-starred expedition to Africa,—Bernardes, a court poet and a courtier, being selected in preference to Camoens to accompany the expedition and sing its triumphs. In August occurred the fatal rout of Alcazar-quivir, and the death of the young king, after which, according to the testimony of Bernardo Rodriguez, "Camoens went as one dreaming."

Three months prior to the poet's death, Benito Caldera's Castilian version of the *Lusiad* was printed at Alcalá de Henares, and we may reasonably infer that Camoens saw a copy."

The disaster of Alcazar-quivir shook Portuguese nationality to its base. In the last letter Camoens penned he alludes to this event. "I have so loved my country that not only do I deem myself happy to die in her bosom but happy to die with her.

The sad sickness unto death came at last, on the 10th of June, 1580. In a small, cheerless room of a shabby house in the Rua de Santa Ana (No. 52 or 54) Luiz de Camoens died, and he was buried in the neighbouring convent of Santa Ana. On the fly-leaf of a copy of the first edition of the *Lusiad* (said to be in the library of Holland House), and in the handwriting of Fray José Indio, a Carmelite monk of Guadalajara, is found the following statement:—

> "What thing more grievous than to see so great genius lacking success! I saw him die in a hospital in Lisbon, without a sheet to cover him, after having triumphed in the Indies, and having sailed five thousand five hundred leagues by sea. What warning so great for those, who, by night and day, weary themselves in study without profit, like the spider weaving a web to catch small flies."

Some picturesque and touching, but probably apocryphal narratives are chronicled by Camoens's biographers. One tells of the faithful Javanese Antonio sallying forth at eventide to beg from passers-by the means to procure a modest meal for himself and his master; another, of Barbara, a mulatto woman, who, from the scanty store upon her stall and the still scantier treasury of her pocket, spared a daily ration and an occasional silver coin in pity for one she might have known prosperous at Macao; and a third of a "fidalgo," named Ruy Diaz de Camara, who came to his poor dwelling to complain of the non-fulfilment of a promise of a translation of the penitential psalms, and to whom Camoens replied—"When I wrote verses I was young, had ample food, was a lover, and beloved by many friends and by the ladies; therefore, I felt poetic ardour. Now I have no spirit, no peace of mind; behold there my Javanese who asks me for two coins to purchase fuel, and I have none to give him." On his deathbed he is said to have exclaimed, "Who ever heard that on so small a stage as a poor bed, Fortune should care to represent so great misfortune, and I, as if such were not sufficient, place myself on her side, because to dare to resist such ills would appear effrontery."

Camoens was spared the pain and humiliation of seeing a Castilian king upon the throne of Portugal. It is, however, related of Philip II. that, soon after his occupation of Lisbon, he inquired for Camoens, and finding him already dead, gave (as documentary evidence shows) instructions that a pension be granted to the poet's mother, still "very old and very poor." She survived the poet some years.

Of Camoens's personal appearance Manoel Severim de Faria, one of his biographers, writes thus: "He was of middle stature, his face full, and his countenance slightly lowering; his nose long, raised in the middle, and large at the end. He was much disfigured by the loss of his right eye. Whilst young his hair (like Tasso's) was so yellow as to resemble saffron. Although his appearance was not perhaps prepossessing, his manners and conversation were pleasing and cheerful. He was afterwards a prey to melancholy, was never married, and left no child." On a marble slab fixed in the wall of the church of Santa Ana, Dom Gonçalo de Coutinho had an inscription placed; but as both church and inscription perished in the earthquake of 1755, there is some doubt as to its precise wording, and whether "he lived poor and neglected and so died" formed part of it or not.

Amid many tributes to Camoens's memory, those of Manoel de Sousa, Diogo Bernardes, Tasso, and Lope-de-Vega are well known. The last alludes to him as "the divine Camoens," and adds, "Strange fortune that to so much wit and learning gave a life of poverty and a rich sepulchre."

A Spanish biographer of Cervantes has shown "that the most remarkable coincidence of fortune may be traced in the events which marked the lives of Camoens and the author of *Don Quixote*."

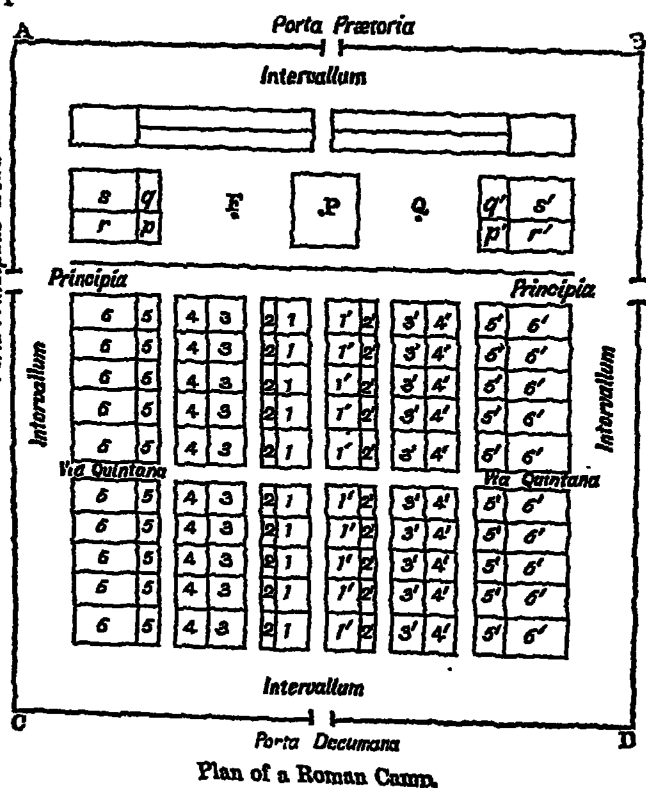
Estimating the popularity of Camoens great epic *Os Lusiadas* by the number of editions printed in Portugal, it was without question considerable, no less than thirty-eight having been published at Lisbon prior to the year 1700, and in addition four in Spain,—three in Castilian and one in Portuguese. There exist translations in English, French, German, Italian, Dutch, Polish, Bohemian, Danish, Swedish, Russian, Latin, Greek, and even Hebrew. The earliest in English is by Sir Richard Fanshaw (London, 1655), and was composed during his banishment at Tankersley Park, Yorkshire, in 1652. Had he lived to prepare a second edition, many errors and imperfections arising from an incomplete knowledge of the Portuguese idiom would, no doubt, have been rectified. He was appointed ambassador to Portugal in 1661, where he remained three years, being then transferred to Madrid, where he died in 1666. Mickle's *Lusiad* was first published in 1776, and hardly merits Southey's condemnation (he preferring that of Fanshaw) of "most unfaithful." It is fairly close in places, but much of the force of the original is sacrificed for the sake of smooth versification. Another translation by Musgrave in blank verse appeared in 1826, the latter cantos of which are closer and more effective than the earlier. A version of the first five cantos by Quillinan followed in 1853, rendered with considerable grace and with greater accuracy than Mickle's. In 1854 appeared a version by Sir Thomas Mitchell.

In estimating the genius of Camoens, it must be remembered that "we build with ready materials, but he dug the quarry, rough-

hewing and polishing with his own hands the material for his edifice." He strengthened and polished the Portuguese language, and his influence preserved it from destruction as an idiom during the Spanish occupation, when the language of the court was Castilian. The circumstances under which his great epic was penned were peculiarly unfavourable to the production and elaboration of such a work; still he triumphed over every difficulty, and produced the epic master-piece of his age. Theophilo Braga, his latest Portuguese biographer, observes, "In Camoens we find exemplified that tradition which insures moral unity to a people, and is the bond which constitutes their nationality, as in the Homeric poems are centered the Hellenic traditions. This same spirit animated Camoens, for in *Os Lusiadas* are gathered together many beautiful and exciting traditions of Portuguese history." Extended and elaborate notices of the *Lusiad* will be found in Adamson, Mickle, and Bouterwek.

Of Camoens's minor works, or *Rimas*, a full and exhaustive notice will be found in *Memoirs of the Life and Writings of Luis de Camoens*, by John Adamson, London, 1820; two exquisite trifles (the originals in Spanish) will be found in Ticknor's *History of Spanish Literature*. Lord Strangford, Adamson, Hayley, and Southey have each translated striking examples of the *Rimas*. (F. W. CO.)

CAMP, Roman. While the Greeks, depending more upon the advantages of situation, adapted the form of their encampment to the nature of the ground selected, the Romans laid out theirs according to a fixed and definite plan, modified only by the numbers for whom accommodation had to be provided. Its form and arrangement in the best days of the republic are minutely and clearly described by Polybius, the companion in many wars of the younger Scipio.



Plan of a Roman Camp.

A Roman camp of the Polybian type was intended primarily to accommodate a consular army, consisting of two legions, each of 4200 infantry and 300 cavalry, with the ordinary contingent of "socii," amounting in all to 16,800 foot and 1800 horse and for this purpose it was pitched in the form of a square, each side of which extended 2017 Roman feet in length. This square was divided into two unequal portions by a perfectly straight road called the "principia," 100 feet in breadth, running parallel with the front and rear of the camp, and forming at its extremities in the sides AC and BD of the camp two gates, the "porta principalis dextra" and the "porta principalis sinistra." In what may be called the upper and smaller portion, determining the arrangement of the rest of the camp, stood the "prætorium" (P), or general's tent, so situated as to have a commanding view in all directions. 100 feet of clear ground on every side left the "prætorium" in the centre of a square, whose sides, each 200 feet in length, were carefully traced parallel to the sides of the camp. To the right and left of the "prætorium," at F and Q, were the "forum," or market-place, and the "quæstorium," or paymaster's tent. Further to the right and left, at (p, q), (p', q'), (r, s), (r', s'), were stationed the cavalry and infantry that formed the bodyguard of the consul and quæstor. Fifty feet in front of the "prætorium," along the line forming the upper boundary of the "principia," were the tents of the twelve tribunes of the legions, six to the right and six to the left of the "prætorium," opposite their respective legions. In the prolongation of the same line were probably stationed the "præfecti sociorum." Passing from the upper to the lower division, or to what was called the front of the camp, we cross the "principia," the great thoroughfare of the army, where the standards of the legion were placed round the altars of the gods. This part of the camp, *i.e.*, between the "principia" and the side CD, was allotted to the main body of the army. It was intersected transversely in the middle by a street 50 feet broad, the "via quintana," as well as longitudinally by what were called the "viæ" or streets of the camp. Each of the latter was also 50 feet in breadth, and the central "via" formed the boundary between the two legions, which were placed symmetrically to the right and left on each side. The "equites," "triarii," "principes," and "hastati" of the legion were stationed in the spaces numbered (1, 1′), (2, 2′), (3, 3′), (4, 4′),—each of the spaces devoted to the cavalry containing, within an area of 10,000 square feet, one squadron of thirty men and horses, while in the same area there were quartered of the "principes" and "hastati" two "maniples" or divisions of sixty men each. Each of the spaces where the "triarii" were stationed was only half this area, and devoted to one "maniple" of sixty men. Spaces (5, 5′), (6, 6′) were assigned to the cavalry and infantry of the allies, of whom, however, a part was quartered in the upper camp. The "velites" (light-armed troops) were probably distributed proportionally among the three-divisions of the infantry. Between the tents and outer wall of the camp there was an "intervallum" all round, 200 feet broad, by which ample room was given for the passage of the legions in and out, and which also served as a receptacle for booty, as well as to increase the distance of the troops from the enemy. The camp was provided with four gates—(1) "porta principalis dextra," and (2) "porta principalis sinistra," at the extremities of the "principia;" (3), "porta prætoria," on the side nearest the "prætorium," and in the very centre of that side; (4), "porta decumana," in the centre of the side opposite. The fortifications consisted of a fosse or ditch (*fossa*), 9 feet deep and 12 feet wide, the earth from which, as it was dug out, being thrown to the inside, formed, with the addition of turf and stone, a mound (*agger*), on the summit of which were fixed stout wooden stakes (*sudes*).

Such was the general outline of the Polybian camp; but when, under the emperors, changes were made in the constitution of the army, and organization by cohorts was introduced, the form and disposition of a Roman camp underwent modifications that resulted in what has been called the Hyginian camp, from Hyginus, a land surveyor who flourished under Trajan and Hadrian, and who has given an account of its arrangement in his day. The principal points of contrast with the Polybian camp were, that the form was now oblong and did not occupy half so much space, that the troops were stationed in cohorts round the rampart so as to enclose the whole body of foreigners and baggage, and that the fortification was much less substantial.

The ordinary entrenchments thrown up from day to day by a Roman army while on the march were but slight

but, where it was necessary or expedient to remain together for some time, or where it was likely they might reoccupy the same ground, a more permanent camp, with a proportionably stronger rampart, was formed. Such an encampment was called "castra stativa," or a stationary camp. This, again, was distinguished as "castra æstiva," a permanent summer camp, and "castra hiberna," a permanent winter camp. Such were the camps that, in process of time, becoming surrounded by a numerous population, formed the nucleus of large towns, many of which may be recognized in England by the name-termination "chester" or "cester."

CAMPAGNA, a town of Italy, in the province of Principato Citeriore, 19 miles east of Salerno. It stands in the centre of a mountainous district, of which it is the capital. It is the see of a bishop, and contains a cathedral and college, besides several churches and convents. Population, 9813.

CAMPAGNA DI ROMA, is, in the wider application of the word, an extensive plain of central Italy, almost coinciding with the ancient Latium, and, in a more restricted signification, that portion of the larger area which lies immediately round the city of Rome between the Tiber and the Anio. The circumference of the latter "might be marked," says Gregorovius, "by a series of well-known points,—Civita Vecchia, Tolfa, Ronciglione, Soracte, Tivoli, Palestrina, Albano, and Ostia;" while the former may be regarded as bounded on the N. by the Mountains of Viterbo (*Sylva Ciminia*), on the E. by the lower ranges of the Apennines, and on the S. and W. by the Tyrrhenian Sea. It extends about 84 miles in length from Civita Vecchia to Terracina, and has a breadth of 24 miles,—its area being nearly 1400 square miles. Of distinctly volcanic formation, the surface presents a very undulating appearance, broken by deep gullies and studded with extinct craters, that now form the basins of lakes, such as those of Bolsena, Vico, and Baccano. In ancient times it seems to have been a well-peopled region, and was the seat of numerous cities; but in the 3d and 4th centuries B.C. the Roman aristocracy turned the most of the district into huge estates, and thus led to the disappearance of the agricultural population. In the earlier period of the empire its condition grew worse and worse, and many parts of the plain became covered with pestilential marshes. The emperors Claudius, Nerva, and Trajan turned their attention to the amelioration of the district, and under their example and exhortation the Roman aristocracy erected numerous villas within its boundaries, and used them at least for summer residence. With the ruin of the empire and the inroad of the barbarian hordes the desolation of the Campagna was complete; but, again, in the Middle Ages, it became dotted over with the baronial castles of the rival families of Rome—the Orsini, the Colonnas, the Savelli, the Conti, and the Caetani—who ruthlessly destroyed the remains of earlier edifices to obtain materials for their own. Several of the popes, as Boniface IX., Sixtus IV., and Julius III., made unsuccessful attempts to improve the sanitary condition of the Campagna; and equally fruitless in more recent times—as far, at least, as the general purpose is concerned—have been the efforts of Popes Pius VI. and VII., and of General Miollis, the French governor of Rome. The most healthy portions of the territory are in the north and east, embracing the slopes of the Apennines which are watered by the Teverone and Saccho; and the most pestilential is the stretch between the Lepini Hills and the sea. The Pontine marshes, included in the latter division, were drained, according to the plan of Bolognini, by Pius VI.; but though they have been restored to cultivation, their insalubrity is still notorious. The soil in many parts is very fertile; and the atmosphere, which is so deadly to man, has no hurtful effect on the lower animals. In summer, indeed, the vast expanse is little better than an arid steppe; but in the winter it furnishes abundant pasture to flocks of sheep and herds of silver-grey oxen and shaggy black horses. The land is for the most part let by the proprietors to *Mercanti di Campagna*, who employ a subordinate class of factors (*fattori*) to manage their affairs on the spot. It is evident that the malaria which renders the Campagna almost uninhabitable during the summer is owing to natural causes affecting a wide area with which it is very difficult to deal, and that no merely local improvements can have any effect. The regulation of the rivers is so defective that they annually overflow a great extent of surface; the character of the soil allows the waters to gather in fetid masses, and the heat of summer turns them into noxious vapours. The attention of the Italian Government and of General Garibaldi has recently been turned towards the systematic sanitary improvement of the district, —with what results remains to be seen. The planting of the *Eucalyptus globulus* and the *Helianthus annuus* has been partially resorted to, especially in the district of Tre Fontani, and, it is reported, with some success.

Full details on the Campagna will be found in Westphal, *Die Römische Campagna*, 1829; Didier, *La Campagne de Rome*, 1842; Adolph Stahr, *Ein Winter in Rom*, 1847–50; Paolo Mantovani, *Descrizione geologica della Campagna Romana*, Turin, 1875; Dr Pietro Balestra, *L'Igiene nella Campagna e città di Roma*, 1875; Augustus Hare, *Days near Rome*, 1875. See also an article by Fr. Siebmann in *Ausland* for August 1875, and another by Fr. von Hellwald in the following number.

CAMPAN, Jeanne Louise Henriette (1752–1822), *née* Genest, was born at Paris in 1752. Carefully educated, and surrounded by the most cultivated society, at the age of fifteen she had gained so high a reputation for her accomplishments as to be appointed reader to the young princesses. At court she was a general favourite, and when she bestowed her hand upon M. Campan, son of the secretary of the royal cabinet, the king gave her an annuity of 5000 livres as dowry. She was soon after appointed first lady of the bedchamber by Marie Antoinette; and she continued to be the faithful attendant of that princess till she was forcibly separated from her at the sacking of the Tuileries, on 20th June 1792. After this event Mme. Campan, almost penniless, and thrown on her own resources by the illness of her husband, bravely determined to support herself by establishing a school at Saint-Germain. The institution prospered, and was patronized by Mme. Beauharnais, whose influence led to the appointment of Mme. Campan as superintendent of the academy founded by Napoleon at Ecouen, for the education of the daughters and sisters of members of the Legion of Honour. This post she held till it was abolished at the restoration of the Bourbons, when she retired to Mantes, where she spent the rest of her life amid the kind attentions of affectionate friends, but saddened by the loss of her only son, and by the calumnies circulated on account of her connection with the Bonapartes. She died in 1822, leaving interesting *Mémoires sur la vie privée de Marie Antoinette, suivis de souvenirs et anecdotes historiques sur les règnes de Louis XIV.–XV.* (Paris, 1823); a treatise *De l'Éducation des Femmes*; and one or two small didactic works, written in a clear and natural style.

CAMPANELLA, Tomaso (1568–1639), one of the most brilliant and unfortunate of the Italian Renaissance philosophers, was born at Stilo in Calabria in 1568. At a very early age he showed remarkable mental power; his memory was uncommonly tenacious, and before he was thirteen years of age he had mastered nearly all the Latin authors presented to him. In his fifteenth year he entered the order of the Dominicans, attracted partly by reading

the lives of Albertus Magnus and Aquinas, partly by his intense love of learning. He was placed at first in the convent at Morgentia in Abruzzo, and after completing his course of philosophy was transferred to Cosenza, there to study theology. He soon became discontented with his teachers, for he earnestly desired to read, not only the works of Aristotle, but the book of nature, which was the language of God. An accident drew his attention to the work *De Rerum Natura* of Telesius, which he read with great eagerness. He was delighted with its freedom of speech and its appeal to nature rather than to authority. His first work in philosophy, for he was already the author of numerous poems, was a defence of Telesius against the attacks of Marta, an Aristotelian. It was styled *Philosophia sensibus demonstrata*, and appeared in 1591. The freedom and boldness of his attacks upon established authority soon brought him into disfavour with the clergy. He left Naples, where he had been residing, and proceeded to Rome For seven years he led an unsettled life, wandering through Padua, Bologna, Venice and other towns, everywhere attracting attention by the brilliancy of his talents and the boldness of his teaching. Yet Campanella was strictly orthodox, held the established faith, and was an uncompromising advocate of the Pope's temporal power

He returned to Stilo in 1598. In the following year he was arrested and committed to prison. What was the immediate cause of this is not clearly known. According to the most common report the motives for his imprisonment were entirely political. He had joined himself to those who desired to free Naples from Spanish tyranny, and had excited them by his fiery eloquence and independence of spirit. His friend Naudée, however, declares that this was a complete mistake, and that the expressions used by Campanella, which were interpreted as revolutionary, had quite a different reference and signification. Whether from error or not, the unfortunate philosopher was committed to prison, and remained there for twenty-seven years, suffering much torture and misery. Yet his spirit was unbroken; he composed sonnets, and prepared a series of works, forming a complete system of philosophy, which were published at a later date. During the latter years of his long confinement he was kept in the castle of St Elmo, and was allowed considerable liberty. There seem, indeed, to have been great doubts even in the minds of those who imprisoned him whether he had done anything deserving such a punishment. Still he was looked upon as dangerous, and it was thought better to restrain his boldness. At last, in 1626, he was set at liberty For some three years he was confined in the chambers of the Inquisition, but in 1629 he was fairly free. He was well treated at Rome by the Pope, but he made enemies; and, profiting by the lessons of experience, he thought it well to avoid future danger by taking flight from Rome. He came to Paris in 1634 under the protection of the French ambassador to Italy, and was received with marked favour by Cardinal Richelieu. The last few years of his life he spent in preparing a complete edition of his works; but only the first volume appears to have been published. He died on the 26th of May 1639.

The philosophy of Campanella is in many respects interesting and important, but it has much that is fantastic, and is wanting in unity and completeness. With Telesius he agreed in rejecting the Aristotelian method of inference. According to him truth or certainty is only to be found in immediate intuition. The sciences are not to be constructed from definitions by deduction, but proceed by induction to definition, which in the natural order comes last. The syllogism is only useful for expounding; the universal rule which it involves is always a result of induction; and the particular subsumed under it is itself part of the induction. Our knowledge begins in doubt. We know neither the past nor the future; even in the present we only know things as they appear to be, not as they are. The first proposition in a theory of cognition is that I myself think; the certainty of self-consciousness is the primary truth.

With all this freedom of philosophizing Campanella preserved a completely orthodox respect for revealed religion; he aimed indeed at a system which should embrace in one comprehensive scheme religious and philosophical principles. His view of God is not far removed from that of Bruno; he lays stress upon the divine unity and omnipresence, and as he is convinced that community of action is only possible where there is identity of being, he is driven to an apparently pantheistic conclusion. God is the ultimate unit; His three manifestations may be called power, wisdom, and love. He alone has pure being; all other things created by or emanating from Him are limited, *i.e.*, have non-being. All things are of the same nature, otherwise there could be no mutual action; there is a universally diffused life and sensibility.

In his natural philosophy Campanella mainly follows Telesius, and lays down as fundamental forces heat and cold, in their concrete form, sun and earth. By these all things are formed. The soul of man is in nature corporeal, but is immortal, being endowed with a striving after happiness never attained in this life.

In practical philosophy Campanella was an extreme reformer. In his *Civitas Solis* he sketches an ideal state, in which principles of communism are fully carried out. He contends for a community of goods and wives, for state control of population, and for a universal military training. The king in his ideal state is called Hoh, *i.e.*, Metaphysics; his ministers have names meaning respectively Power, Wisdom, and Might. The whole work is cold and abstract, utterly wanting in the rich practical detail of its prototype, the *Utopia*.

A long list of Campanella's works is given by Echard, App. to Cypriano, *Vita Campanellæ*, who enumerates eighty-two, and by Campanella himself in the first vol. of his collected works. The most important were *De Sensu Rerum*, 1620; *Realis Philosophiæ Epilogisticæ Partes IV.* (containing *Civitas Solis*), 1623; *Atheismus Triumphatus*, 1631; *Philosophia Rationalis*, 1637; *Philosophia Universalis seu Metaphysica*, 1638; *De Monarchia Hispanica*, 1640, translated into English.

See on his life Cypriano, *Vita Campanellæ*, 1705, 1722; Baldacchini, *Vita et Filosofia di Tomaso Campanella*, 1840. On his philosophy, see Ritter, *Ges. d. Phil.* vol. ix., who gives a very full account; Carriere, *Phil. Weltanschauung der Reformationszeit*, 522–608; Dareste, *Th. Morus et Campanella*, 1843. Some of the works have been translated into French, *Œuvres choisies de Campanella*, par Mme. L. Collet, 1844; *Cité du soleil*, par Villegardelle, 1840.

CAMPANIA, an ancient province of Italy, separated from Latium on the N. by the Massican Hills, and from Samnium on the E. by the Apennines, and bounded on the W. by the Tyrrhenian Sea, and on the S. by Lucania. It was distinguished by its fertility, beauty, and genial climate, and by the excellence of its harbours. It consists of a plain, broken only by a low volcanic range of hills, of which the chief is Mons Gaurus, and by Mount Vesuvius. The original inhabitants of Campania were Oscans or Ausonians. The first settlers were the Greeks who founded Cumæ, and afterwards Dicæarchia, Palæpolis, and Neapolis. It seems pretty certain that the next invaders were the Etruscans, and that they founded Capua and Nola. The Etruscans in turn had to give place to the Samnites. But both these invaders were few in number; and the Campanian people continued to be of essentially Oscan race. The remains of their language are, indeed, our best specimen of Oscan. In the 4th century B.C. war broke out with the Romans, and in 340 B.C., by the battle of

Vesuvius, Campania fell into their hands. For subsequent history see ROMAN HISTORY. The Bay of Naples was one of the favourite situations for the villas of the ancient Romans; and, notwithstanding the eruption of Vesuvius in 79 A.D., which buried the cities of Herculaneum and Pompeii, Campania continued to flourish. The chief towns were Capua, Cumæ, Neapolis, Nola, Pompeii, Herculaneum, Vulturnum, Puteoli, Liternum, Teanum, Salernum, Suessa, Misenum, Surrentum, Picentia. The province was traversed by several roads—the Via Appia, the Via Latina, part of the high road from Rome to Rhegium, and a road constructed by Domitian along the coast from Sinuessa to Neapolis. Under Augustus, Campania was joined to Latium to form the First Region of Italy Its name then gradually superseded that of Latium; so that at present the district round Rome is known as the Campagna di Roma.

CAMPANI-ALIMENIS, MATTEO, an Italian mechanician and natural philosopher of the 17th century, was born at Spoleto. He held a curacy at Rome in 1661, but devoted himself principally to scientific pursuits. As an optician, he is chiefly celebrated for the manufacture of the large object-glasses with which Cassini discovered two of Saturn's satellites, and for an attempt to rectify chromatic aberration by using a triple eye-glass; and in clock-making, for his invention of the illuminated dial-plate, and that of noiseless clocks, as well as for an attempt to correct the irregularities of the pendulum which arise from variations of temperature. Campani published in 1678 a work on horology, and on the manufacture of lenses for telescopes. His younger brother Giuseppe was also an ingenious optician (indeed the attempt to correct chromatic aberration has been ascribed to him instead of to Matteo), and is, besides, noteworthy as an astronomer, especially for his discovery, by the aid of a telescope of his own construction, of the spots in Jupiter, the credit of which was, however, also claimed by Divini.

CAMPANILE, the bell tower attached to the churches and town-halls in Italy. Bells are supposed to have been first used for announcing the sacred offices by Pope Sabinian (604), the immediate successor to St Gregory; and their use by the municipalities came with the rights granted by kings and emperors to the citizens to enclose their towns with fortifications, and assemble at the sound of a great bell. It is to the Lombard architects of the north of Italy that we are indebted for the introduction and development of the campanile, which, when used in connection with a sacred building, is a feature peculiar to Christian architecture,—Christians alone making use of the bell to gather the multitude to public worship. The campanile of Italy serves the same purpose as the tower or steeple of the churches in the north and west of Europe, but differs from it in design and position with regard to the body of the church. In the north and west the tower forms an integral part of the building; it is frequently placed at the west end or at the south or north side of the nave, in which case the ground story forms a porch to the church; sometimes it is at the intersection of the nave and transepts, in which case it rises as a grand central feature round which everything else groups, as seen at Salisbury, Lincoln, Norwich, &c. In Italy the campanile is almost always detached from the church, or at most connected with it by an arcaded passage. In Italy there are (with one or two exceptions, such as San Ambrosio, Milan, and at Novara) never more than one campanile to a church, whereas in the north and west the number varies from one to seven.

The design of the campanile differs entirely from its northern type. It never has buttresses, is very tall and thin in proportion to its height, and is square on plan, occasionally round, as at Ravenna and Pisa, and in one or two cases, as at San Gottardo, Milan, octagonal. The campanile generally rises from base to summit without break; the faces are divided vertically by flat pilasters, and horizontally by string-courses, arcades, or windows. As a rule the openings increase in number with the height of the stage. Many, perhaps the finest examples, have openings at the top only.

The chief architectural defect of the square campanile is the covering. This is generally a short conical roof, either square, circular, or octagonal on plan; but its junction with the tower was never successfully managed. The campanili in the north of Italy and in Rome are nearly all built of brick. In Tuscany, as at Pisa and Siena, and further south, as at Viterbo, they are veneered with marble of various colours.

The tallest campanile is the one at Cremona; it rises to a height of 396 feet. Probably the grandest and richest is that designed by Giotto in 1334 for the cathedral at Florence. It measures 275 feet high and 45 feet square; it is entirely veneered with black, red, and white marble, and is divided into five stages, the upper three only having windows. Giotto intended to have finished it with a spire 90 feet high, but Taddio Gaddi, who succeeded Giotto as architect, thinking that the tower would not be improved by it, left it as it now exists. Some of the best examples of church campanili are to be found in Venice, Verona, Modena, Cremona, Parma, and Pisa.

The campanili belonging to the municipalities have generally a distinct character from those attached to sacred edifices; they have a smaller section on plan in proportion to the height. They want the conical roof, and are generally battlemented; some have an upper and smaller stage, wherein the bells are hung, as at Florence, Siena, Volterra, and Montepulciano. Their faces are rarely divided by pilasters; there are few windows, generally small openings only to light the staircase; and they are more frequently incorporated with the body of the building than the church campanili, often rising from the wall heads and not from the ground to great heights. The most remarkable campanili are those at Venice, Florence, Pisa, and Siena. The campanile of St Mark's at Venice stands in the great square in front of the cathedral. Its erection was commenced about the beginning of the 10th, and completed up to the belfry about the middle of the 12th century. The belfry was erected and finished by Bartolomeo Buono in 1517. From the level of the piazza to the belfry stage, it is constructed of brick; the belfry and surmounting pyramid are of marble. The total height is 323 feet, and it is 42 feet square at the base. The gallery at top is reached by an inclined plane, and there are no windows other than small openings lighting the ascent.

The leaning tower or campanile of Pisa, built by the citizens to rival that of Venice, was erected by Bonanno, and begun in the year 1174. It is circular on plan, and about 51 feet in diameter and 172 feet high. Not including the belfry it is divided vertically into seven stages, all of which, with the exception of the lowest, are decorated with an open arcade. The conical covering of the belfry was never constructed. This tower overhangs its base upwards of 13 feet, and for long it was supposed to have been built so. It is founded on wooden piles driven into boggy ground. When the tower had been carried up about 35 feet it began to settle to one side. That no such settlement was ever anticipated may be asserted from the fact that a gurgoyle or water-spout to throw off the water from the first arcade, may be observed on what is now the highest side. As the work was carried on, the levels were altered so as to keep the centre of gravity within the base. This tower was finished by an architect called William of Innspruck. The outside is entirely constructed

of white marble, and the inside of stone from Verruca. There are many campanili, notably the Garisendi and Asinelli towers at Bologna, that incline to one side,—all from the same cause as at Pisa.

The campanili of Florence and Siena are somewhat similar in design. The one at Florence is built of stone, and is about 20 feet square and about 300 feet high. That at Siena is built entirely of brick, and measures about 21 feet square and 282 feet high. Both are battlemented and have a smaller upper stage for the belfry. Several other important examples exist at Volterra, Montepulciano, Figline, Oppi, &c., &c. (R. AN.)

CAMPBELL, SIR COLIN. See CLYDE, LORD.

CAMPBELL, GEORGE (1719-1796), a theologian and Biblical critic, was born at Aberdeen on the 25th December 1719. His father, the Rev. Colin Campbell, one of the ministers of Aberdeen, was the son of George Campbell of Westhall, who claimed to belong to the Argyll branch of the family. Mr Colin Campbell died in 1728, leaving a widow and six children in somewhat straitened circumstances. George, the youngest son, was destined for the legal profession, and after attending the grammar school of Aberdeen and the arts classes at Marischal College, he was sent to Edinburgh to serve as an apprentice to a writer to the Signet. But he does not seem to have had any liking for law—at any rate he found in theology a study much more to his taste. While at Edinburgh he fell into the habit of attending the theological lectures, and this was followed, when the term of his apprenticeship expired, by his enrolment as a regular student in the Aberdeen divinity hall. After a distinguished career he was, in 1746, licensed to preach by the Presbytery of Aberdeen; but his first attempt to obtain a charge—that of Fordoun in Kincardineshire—was unsuccessful. In 1748, however, he was ordained minister of Banchory Ternan, a parish on the Dee, some twenty miles from Aberdeen. Here he spent the next nine years, labouring with much success as a country minister, and planning two at least of the works by which he was afterwards to make himself known. In 1757 he left Banchory Ternan to become one of the ministers of Aberdeen. That city was at the time the centre of no inconsiderable intellectual activity. Reid was professor of philosophy at King's College; John Gregory, Reid's predecessor, held the chair of medicine; Alexander Gerard was professor of divinity at Marischal College; and in 1760 Beattie became professor of moral philosophy in the same college. These men, with others of less note, formed themselves in 1758 into a society for the discussion of questions in philosophy. Reid was its first secretary, and Campbell one of its founders. It lasted till about 1773, and during this period not a few papers were read, particularly those by Reid and Campbell, which were afterwards extended in the form of published treatises.

Meanwhile Campbell was, in 1759, made principal of Marischal College, an appointment due rather to the high estimation in which he was held by those who knew him, and perhaps also to his family influence with the duke of Argyll, than to any published evidence he had given of his fitness for the post. But this evidence, if it was required, was soon forthcoming. In 1763 he published his celebrated *Dissertation on Miracles*, a work that originated in a sermon preached two years previously before the Synod of Aberdeen. In it he seeks to show, in opposition to Hume, that miracles are capable of proof by testimony and that the miracles of Christianity are sufficiently attested. Hume derived our belief in testimony equally with our belief in the laws of nature from experience; he held that where the laws of nature, being a uniform experience, contradict testimony, the latter must give way; and he further held that in the case of miracles the laws of nature do actually contradict the testimony in favour of miracles, *i.e.*, miracles are incapable of proof. In reply Campbell asserts—(1) that testimony is not derived from experience, but "has a natural and original influence on belief antecedent to experience." As, however, he admits that experience is, if not the source, at least the measure, of testimony, he virtually grants all that Hume desires, and leaves the question where it was. But (2) he urges, and with more success, that testimony can prove a miracle. There is no contradiction, he argues, as Hume said there was, between what we know by testimony and the evidence upon which a law of nature is based; they are of a different description indeed, but we can without inconsistency believe that both are true. He also dwells at considerable length upon the ambiguity of the word "experience" as it is used by Hume, and devotes the rest of the work to a discussion of the actual evidence for the miracles of Christianity. The *Dissertation* is not a complete treatise upon miracles, and does not approach the subject from points of view it would be regarded from now, but with all deductions it was and still is a valuable contribution to theological literature.

In 1771 Campbell was elected professor of theology at Marischal College, and in consequence he resigned his city charge, although he still preached as minister of Greyfriars, a duty then attached to the chair. His next work was not a theological one. During his early ministerial life at Banchory Ternan he planned and began the composition of a work on rhetoric. The results of his labours were partly communicated to the Aberdeen Philosophical Society, for most of the papers he read there were on "Eloquence" and cognate subjects; but it was not until 1776 that his *Philosophy of Rhetoric* appeared,—a work that at once took a high place among books on the subject, which it can hardly be said even now to have lost. The most interesting portion is perhaps that which treats of evidence; certainly the least satisfactory is that on the syllogism. In 1778 his last and in some respects his greatest work appeared, *A New Translation of the Gospels*. The translation is a good one, but it is the critical and explanatory notes which accompany it that give the book its high value. Several of his sermons were published, notably one in 1777 *On the Success of the first publishers of the Gospel, considered as a proof of its truth*. It was preached before the Society for Propagating Christian Knowledge, and is one of the happiest specimens of his style and method of argument.

Campbell, who had never enjoyed robust health, was in 1795 compelled by increasing weakness to resign the offices he held in Marischal College, and on his retirement he received a pension of £300 from the king. He did not long enjoy the royal bounty, for he died on the 31st of March 1796 of a stroke of palsy. Principal Campbell had married Miss Grace Farquharson, daughter of Mr Farquharson of Whitehouse. They had no children. In church politics he belonged to the moderate side, but his independence of judgment and strength of conviction were too great to permit him to be confined by the trammels of party. It is as a theologian and as a scholar, the acutest and most cultivated that the Church of Scotland has produced, that he will be best remembered.

His *Lectures on Ecclesiastical History* and some smaller writings were published after his death; and there is a uniform edition of his works in six vols. 8vo. A short account of his life, by the Rev. Mr Keith, is prefixed to his *Lectures on Church History*.

CAMPBELL, JOHN, LL.D. (1708-1775), a miscellaneous author, was born at Edinburgh, March 8, 1708. Being designed for the legal profession, he was sent to Windsor, and apprenticed to an attorney; but his tastes soon led him to abandon the study of law, and to devote himself entirely to literature. In 1736 he published

the *Military History of Prince Eugene and the Duke of Marlborough*, and soon after contributed several important articles to the *Ancient Universal History*. In 1742 and 1744 appeared the *Lives of the British Admirals*, in 4 vols., a popular work which has been continued by other authors. Besides contributing to the *Biographia Britannica* and Dodsley's *Preceptor*, he published a work on *The Present State of Europe*, consisting of a series of papers which had appeared in the *Museum*. He also wrote the histories of the Portuguese, Dutch, Spanish, French, Swedish, Danish, and Ostend settlements in the East Indies, and the histories of Spain, Portugal, Algarve, Navarre, and France, from the time of Clovis till 1656, for the *Modern Universal History*. At the request of Lord Bute, he published a vindication of the Peace of Paris concluded in 1763, embodying in it a descriptive and historical account of the New Sugar Islands in the West Indies. By the king he was appointed agent for the provinces of Georgia in 1755. His last and most elaborate work, *Political Survey of Britain*, 2 vols. 4to, was published in 1744, and greatly increased the author's reputation. Campbell died December 28, 1775. He received the honorary degree of LL.D. from the University of Glasgow in 1745.

CAMPBELL, Thomas (1777–1844). This distinguished poet was a cadet of the respectable family of Campbell of Kirnan, in Argyllshire. Owing to the straitened circumstances of his father, who had settled in Glasgow and been unfortunate in business, young Campbell was obliged, while attending college, to have recourse to private teaching as a tutor. Notwithstanding the amount of additional labour thus entailed, he made rapid progress in his studies, and attained considerable distinction at the university over which it was his fortune, in after years, to preside. He very early gave proofs of his aptitude for literary composition, especially in the department of poetry; and so strong was his addiction to these pursuits, that he could not bring himself seriously to adopt the choice of a profession. From private tuition, which is at best an irksome drudgery, he recoiled after a short trial. Neither law, physic, nor divinity had any attractions for him; nor is it probable that he ever would have risen to eminence in a regular profession, owing to a constitutional sensitiveness almost morbid, and a want of resolute energy. We are told by his friend and biographer Dr Beattie that "the imaginative faculty had been so unremittingly cultivated that circumstances, trifling in themselves, had acquired undue influence over his mind, and been rendered formidable by an exaggeration of which he was at the moment unconscious. Hence various difficulties, which industry might have overcome, assumed to his eye the appearance of insurmountable obstacles. Without resolution to persevere, or philosophy to submit to the force of necessity, he drew from everything around him, with morbid ingenuity, some melancholy presage of the future. He was dissatisfied with himself, chilled by the world's neglect, and greatly hurt by the apathy of friends who had extolled his merits, but left him to pine in obscurity." Campbell was not a man who could have successfully struggled with the world. Fortunately for him, his genius was such as to ensure an early recognition.

We find him at the age of twenty in Edinburgh, attending lectures at the university, soliciting employment from the booksellers, and not unknown to a circle of young men then resident in the Scottish metropolis, whose names have become historical. Among those were Walter Scott, Henry Brougham, Francis Jeffrey, Dr Thomas Brown, John Leyden, and James Grahame, the author of the *Sabbath*. He also became acquainted with Dr Robert Anderson, editor of a collection of the British poets, a man of extreme enthusiasm and kindliness of disposition, who early appreciated the remarkable powers of Campbell, and encouraged him to proceed in his literary career. In 1799 his poem, *The Pleasures of Hope*, was published.

Probably there is no parallel instance of literary success so instantaneously achieved by a first effort; nor was that owing to novelty of design on the part of the author, or the caprice of the public. For considerably more than half a century the poem has maintained, nay, increased its popularity. During that time the public has adopted and abandoned many favourites—names once famous and in every mouth have gradually become forgotten and unregarded—poetical works of greater pretension, which were once considered as masterpieces of genius and inspiration, have fallen into neglect; but this poem by the boy Campbell remains a universal favourite. It is not much to say that it is, without any exception, the finest didactic poem in the English language. Even those who are not admirers of didactic poetry are forced to admit its charm; and the uttermost objection that criticism can make appears to be a certain vagueness, which, after all, is inseparable from the nature of the subject and the necessary plan of the composition. The delicacy of the thoughts, the beauty of the imagery, the occasional power of pathos, the extraordinary felicity of the language, and the wonderful harmony of the versification, distinguish the *Pleasures of Hope* from any poem which has been written before or since, and entitle it to a very high place as an original work of genius. It is as original and characteristic of its author as is the *Deserted Village* of Goldsmith, with which it has been frequently, but surely improperly compared. Goldsmith's poem affects us by its simplicity and truth. Campbell's, it must be owned, is much more florid and ornamented; but how exquisite is the taste of the ornament!

The literary and the private histories of an author are inseparable. In order to comprehend the one we must have recourse to the other. The first success of Campbell brought him fame, but not fortune. He had disposed of the copyright of the *Pleasures of Hope*, by his original bargain with the publishers, for a sum certainly moderate, which, however, probably exceeded his expectations at the time. He was, moreover, very kindly treated, for he received a considerable unstipulated allowance for each new edition, which circumstance ought to have deterred him from uttering certain diatribes against "the trade," in which he was afterwards rather prone to indulge. The fact is that he did not know how to make use of his success. Instead of availing himself of the reputation which he had so worthily and decisively won, and applying himself to a new effort, he went abroad without any determinate aim; was perfectly wretched on the Continent, where he had no friends, and was sorely embarrassed for want of means; and began to write fugitive poetry for the London journals. On his return to Britain he had ample opportunity of bettering his condition. With a name such as his, a moderate amount of exertion would have secured him not only a competence but comparative affluence; but indolence, perhaps the result of timidity, had grown upon him. Campbell never could adapt himself even to the profession of literature, which, precarious though it be, is not without its prizes. In that profession, as in all others, the requisites for success are steadiness, punctuality, and perseverance; but Campbell possessed none of them. The publishers were ready, and offered to give him lucrative employment, nor was he at all backward in accepting their offers; but when the period for performance arrived he had literally done nothing. In extraordinary contrast to him stands Scott, who seemed simply to will in order to conceive and execute. Campbell had many bright conceptions, but he could not apply himself to the work. Of course he lost repute with the men who alone can intervene between an

author and the public, and "the fathers of the Row" became chary of offering him engagements. Some idea of the extent of his habitual indolence may be formed from the fact, that the publication of his *Specimens of the British Poets* did not take place until thirteen years after the work was undertaken!

In the meantime Campbell married; and his prospects were of the darkest, when, in 1805, he received a Government pension of £200. He was then in great distress, and even that aid, material as it was, failed to extricate him. It was probably fortunate for his fame that such was the case, for in 1809 he published his poem of *Gertrude of Wyoming*, to which were attached the most celebrated of his grand and powerful lyrics.

Among Campbell's lengthier poems *Gertrude of Wyoming* must hold the second place. He designed it for a poem of action, but he has failed to give it that interest and vivacity which a poem of action requires. There is in it too decided a predominance of the sentimental vein, and an extreme degree of elaboration, which, in poetry as in painting, is hurtful to the general effect. There is great truth in the following criticism, which occurs in a letter from Jeffrey to the author:—"Your timidity or fastidiousness, or some other knavish quality, will not let you give your conceptions glowing, and bold, and powerful, as they present themselves; but you must chasten, and refine, and soften them, forsooth, till half their nature and grandeur is chiselled away from them. Believe me, the world will never know how truly you are a great and original poet till you venture to cast before it some of the rough pearls of your fancy." In spite of these defects, *Gertrude* was considered at the time as a work in every way worthy of the poet's previous reputation; and it will ever be admired by that numerous class of readers who are more fascinated by the beauties of expression than by high inventive power and vigorous execution.

The soundness of the above criticism, proceeding from an eminent literary authority whose whole leanings were rather towards than against fastidiousness in composition, is demonstrated by the universal admiration accorded to Campbell's lyrical pieces. One or two of these, in particular *Lochiel's Warning* and *Hohenlinden*, are to be referred to an earlier period than the composition of *Gertrude*; but there are others of a later date which show how much power remained in the man when he chose to exert it freely. There are few lyrics in the English language to be placed in comparison with the *Mariners of England* or *The Battle of the Baltic*; and his exquisite poem of *O'Connor's Child*, which has not unaptly been termed the diamond of his casket of gems, is greatly superior in pathos and passion to his more elaborate compositions. All these, and others scarcely inferior to them, seem to have been struck off at a heat, and to have escaped that chiselling process to which Jeffrey so pointedly referred.

Campbell was now settled at Sydenham in England, and his circumstances were materially improved. His home was a happy one; the society in which he moved was of the most refined and intellectual character; and he enjoyed the personal friendship of many of his distinguished contemporaries. Ample leisure was afforded him to carry into effect any of the cherished schemes of his literary ambition; but his indolence and inherent want of resolution again interfered. His most noteworthy exertion for years appears to have been the preparation of a short course of lectures on poetry, which he delivered with great *éclat* at the Royal Institution in London and elsewhere. It appears that at one time it was proposed by his friends, and especially by Sir Walter Scott, that he should become a candidate for the occupancy of a literary chair in the University of Edinburgh; but he shrank from the idea of undertaking so serious a labour as is involved in the preparation of a thorough academical course. In 1820 he accepted the editorship of the *New Monthly Magazine*, and acted in that capacity for a considerable period, until he resigned it to take charge of the *Metropolitan*. His connection with periodical literature may have been advantageous in a pecuniary point of view, but did not tend materially to enhance his reputation. His was not the pen of the ready writer; and it must ever be regretted that he was induced to bestow so much attention upon merely ephemeral literature, to the sacrifice of the nobler aims which were expected from his acknowledged genius. In 1824 he published his *Theodric*, a poem which, in spite of some fine passages, was generally considered as a failure. With *Theodric* his poetical career may be said to have closed. At times he put forth short poems of various degrees of merit, but none of them were equal to the grand lyrics already treasured in the memory of his countrymen. It seemed as if a large portion of the old virtue had departed from him; and his last published poem, the *Pilgrim of Glencoe*, showed hardly any marks of his former accomplishment and power.

In fact it appeared that the rich mine of poetry had been worked out. Without actually adopting that conclusion, we may observe that Campbell had latterly occupied himself most zealously with matters which were apart from his earlier pursuits. In the first place, he took an active share in the Institution of the London University, and it was mainly through his exertions that it was saved from becoming a mere sectarian college. Shortly afterwards, in 1826, he was elected Lord Rector of the University of Glasgow, an event which he considered as the crowning honour of his life, and which certainly was a mark of distinction of which any man might have been proud. He did not accept the office as a mere sinecure, but applied himself to discharge the actual duties (which, through the negligence of former rectors, had been allowed to fall into abeyance) with a zeal and energy which made entire conquest of the hearts of his youthful constituents. In 1831, the year in which the gallant struggle of the Poles for their independence was terminated by entire defeat, Campbell, who in his earliest poem had referred in such beautiful language to the shameful partition of Poland, more than revived his youthful enthusiasm for her cause. He had watched with an anxiety almost bordering on fanaticism the progress of the patriotic movement; and the news of the capture of Warsaw by the Russians affected him as if it had been the deepest of personal calamities. "His heart," says his biographer, "was in the subject of Poland; he could neither write nor speak upon any other with common patience; and if a word was dropt in company that did not harmonize with his feelings, he was very apt to consider it as a personal offence." In one of his own letters he says, "I know that my zeal for Poland has put me half mad." And again, "It is still all that I can do to support a tolerable cheerfulness before these kind hospitable people, for Poland preys on my heart night and day. It is sometimes a relief to me to weep in secret, and I do weep long and bitterly." Nor did he show his sympathy by words alone, but by resolute and continued action. He was the founder of the association in London of the Friends of Poland, which not only served to maintain the strong interest felt by the British people for the Polish cause, but was the means of providing assistance and giving employment to large numbers of the unfortunate exiles who were driven to seek refuge in this country. Never, till his dying day, did he relax his exertions in their behalf; and many an unhappy wanderer, who, but for unexpected aid, might have perished in the streets of a foreign city, had reason to bless the name of Thomas Campbell.

The remainder of his life presents few features of interest. Domestic calamity had overtaken him. His wife, whom he loved affectionately, had been taken from him—of his two sons, one died in infancy, and the other was afflicted by an incurable malady. His own health became impaired. He gradually withdrew from public life, and died at Boulogne on 15th June 1844, at the age of sixty-seven. His last hours were soothed by the affectionate care of his relatives and friends; nor did his countrymen forget the poet in his death, for his remains were solemnly interred in Westminster Abbey, with the honours of a public funeral.

Few poets of reputation, whose span has been extended nearly to the threescore and ten allotted years, have written so little as Campbell: at the same time it must be confessed that there are fewer still whose works are likely to be prized by posterity in the like proportion with his. If we throw out of consideration altogether *Theodric*,—though some might demur to such an excision,—if we overlook the *Pilgrim of Glencoe*, and weed from his lyrical garden such plants as have little charm either from their colour or their fragrance, there will still remain a mass of poetry familiar to the ear and the heart, such as hardly any other writer of this century has been able to produce. We may regret that Campbell was not more diligent in the cultivation of his poetical genius, that he did not apply himself more sedulously in his earlier years to some serious effort, and that he allowed other pursuits and designs to interfere with his peculiar calling. But who can venture to say what success might have attended his efforts had he acted otherwise than he did? We blame the poet for apparent indolence, not reflecting that inspiration is not to be commanded at will. It is not only possible but easy for the man who is practised in versification to write a certain given number of lines within a certain specified time; but genuine poetry never was and never will be the product of Egyptian taskwork. It cannot be produced to order—it must be spontaneous; and its quality must depend entirely upon the mood of mind under which it is composed. The greater part of the poetry or rather the verse of Southey, a considerable portion of that of Scott, and a vast deal of that of Wordsworth, was not conceived or written under the poetic impulse. On such occasions these celebrated men were writing verse, as they might have written prose, without enthusiasm or anything like the feeling of passion; and although their ordinary thoughts were far higher, bolder, and more subtle than those of the million, they still were not attempting to rise beyond their ordinary intellectual level. One can see at a glance when they were inspired, and when they were merely versifying. Of the poets who adorned the first half of the present century, Coleridge and Campbell were conspicuous for their abstinence in writing except under the influence of real emotion. Of the former it may be said that he has hardly penned a line of mere mechanical verse; the latter did not do so until his inspiration seemed to have abandoned him. Undoubtedly, however,—to have recourse to a hackneyed, though by no means an unmeaning phrase,—it is the duty of the poet to woo the muse, not to wait for her courtship. He must seek for the waters of Castaly, not tarry till they are conveyed to him; and it is in this respect probably that Campbell principally erred. He did not sufficiently endeavour to awake his genius; he was too much a dreamer, and may at times have lost his opportunity from the sheer weight of indolence. And yet, considering the value of the legacy he has left, we have no reason to complain. Critics may dispute regarding the comparative merits of his longer works; and, as they incline towards didactic or narrative poetry, may prefer the one composition to the other. Both are entitled to high praise and honour, but it is on his lyrics that the future reputation of Campbell must principally rest. They have taken their place, never to be disturbed, in the popular heart; and, until the language in which they are written perishes, they are certain to endure. (W. E. A.)

CAMPBELL, JOHN, BARON (1779–1861), the second son of the Rev. George Campbell, D.D., by Magdalene, the only daughter of John Hallyburton, Esq. of Fodderance, was born at Cupar, Fife, on 17th September 1779. His father was for fifty years the parish minister of Cupar. For a few years young Campbell studied at the United College, St Andrews, where he met Thomas Chalmers. In 1800 he was entered as a student at Lincoln's Inn, and became a pupil of the well-known special pleader Mr Warren, the master of Lyndhurst, Denman, and Cottenham. A few days after his entrance, as he records in his *Lives of the Chancellors*, he saw and heard Lord Thurlow speak in the House of Lords. After a short connection with the *Morning Chronicle* he was called to the bar in 1806, and at once began to report cases decided at *Nisi Prius* (*i.e.*, on Jury Trial), in the courts of King's Bench and Common Pleas, and on the home circuit. Of these *Reports* he published altogether four volumes, with learned notes; they extend from Michaelmas 1807 to Hilary 1816. Campbell also devoted himself a good deal to criminal business, but in spite of his unceasing industry he failed to attract much attention behind the bar; briefs came in slowly, and it was not till 1827 that he obtained a silk gown and found himself in that "front rank" who are permitted to have political aspirations. When George IV. died (26th June 1830) and Parliament was dissolved (24th July), Campbell, like all the new Whig men of the day, resolved to enter Lord Grey's Parliament. With the help of his relative Major Scarlett he contested the borough of Stafford, which he represented in 1830 and 1831. In the House he showed an extraordinary, sometimes an excessive zeal for public business, speaking on all subjects with practical sense, but on none with eloquence or spirit. His main object, however, like that of Brougham, was the amelioration of the law, more by the abolition of cumbrous technicalities than by the assertion of new and striking principles. Thus his name is associated with the Fines and Recoveries Abolition Act (3 and 4 Will. IV. c. 74); the Law of Descent Act (3 and 4 Will. IV. c. 106); the Law of Dower Act (3 and 4 Will. IV. c. 105); the Statute of Limitations (3 and 4 Will. IV. c. 27); the Execution of Wills of Real or Personal Property Act (1 Vict. c. 26); one of the Copyhold Tenure Acts (4 and 5 Vict. c. 25); and the Imprisonment for Debt Act (1 and 2 Vict. c. 110). All these measures were important and were carefully drawn; but their merits cannot be explained in a biographical notice. The second was called for by the preference which the common law gave to a distant collateral over the brother of the half-blood of the first purchaser; the fourth conferred an indefeasible title on adverse possession for twenty years (a term shortened by Lord Cairns in 1875 to twelve years); the fifth reduced the number of witnesses required by law to attest wills, and removed the vexatious distinction which existed in this respect between freeholds and copyholds; the last freed an innocent debtor from imprisonment only before final judgment (or on what was termed *mesne process*), but the principle stated by Campbell that only fraudulent debtors should be imprisoned was ultimately given effect to for England and Wales in 1869.[1] In one of his most cherished objects, however, which formed the theme of his maiden speech in Parliament, Campbell was doomed to disappoint-

[1] Two of his later Acts, allowing the defendant in an action for libel to prove *veritas*, and giving a right of action to the representatives of persons killed through negligence, also deserve mention.

ment. This was the establishment of a general Register of Deeds or Titles to Land for England and Wales, which would diminish the number of unmarketable and unsafe titles, and thus simplify and cheapen the transfer of land. As head of the Real Property Commission of 1827, he had ample opportunity of observing the evils caused by the absurd system of outstanding terms,[1] and he was able to quote the example of most European countries, where compulsory publication had been found neither to hurt commercial credit nor to wound family pride. The measure of 1830 was defeated by the country attorneys, led by Sir Chas. Wetherell, but the principle has rapidly gained ground and has been partially embodied in the Land Transfer Bills of subsequent reformers. Campbell's most important appearance as member for Stafford was in defence of Lord John Russell's first Reform Bill (1831). In a temperate and learned speech, based on Fox's declaration against constitution-mongering, he supported both the enfranchising and the disfranchising clauses, and easily disposed of the cries of "corporation robbery," "nabob representation," "opening for young men of talent," &c. The following year (1832) found Campbell solicitor-general, a knight, and member for Dudley, which he represented till 1834. In that year he became attorney-general and was returned by Edinburgh, for which he sat till 1841.[2]

His political creed declared upon the hustings there was that of a moderate Whig. He maintained the connection of church and state, opposed triennial parliaments and the ballot, and railed against the dictatorship of the great duke (see *Speech* at Edinburgh, 3d January 1835, 8vo, London, 1835). Although in his relations with his constituents in both England and Scotland there was traceable an unpleasant spirit of accommodation and cajolery, in Parliament his position, both political and religious, was always well defined and independent. There he continued to lend the most effective help to the Liberal party. His speech in 1835 in support of the motion for inquiry into the Irish Church Temporalities with a view to their partial appropriation for national purposes (for disestablishment was not then dreamed of as possible) contains much terse argument, and no doubt contributed to the fall of Peel and the formation of the Melbourne cabinet. The next year Campbell had a fierce encounter with Lord Stanley in the debate which followed the motion of Mr Spring Rice on the repair and maintenance of parochial churches and chapels. The legal point in the dispute (which Campbell afterwards made the subject of a separate pamphlet) was whether the churchwardens of the parish, in the absence of the vestry, had any means of enforcing a rate except the antiquated interdict or ecclesiastical censure. It was not on legal technicalities, however, but on the broad principle of religious equality, that Campbell supported the abolition of Church Rates, in which he included the Edinburgh Annuity-Tax. In the same year he spoke for Lord Melbourne in the action (thought by some to be a political conspiracy[3]) which was brought by Mr Norton against the Whig premier for criminal conversation with the beautiful and accomplished grand-daughter of Sheridan. At this time also he exerted himself for the reform of justice in the ecclesiastical courts, for the uniformity of the law of marriage (which he held should be a purely civil contract), and for giving prisoners charged with felony the benefit of counsel. His defence of the *Times* newspaper, which had accused Sir John Conroy, equerry to the duchess of Kent, of misappropriation of money (1838), is chiefly remarkable for the confession—"I despair of any definition of libel which shall exclude no publications which ought to be suppressed, and include none which ought to be permitted." His own definition of blasphemous libel was enforced in the prosecution which, as attorney-general, he raised against the bookseller Hetherington, and which he justified on the singular ground that "the vast bulk of the population believe that morality depends entirely on revelation; and if a doubt could be raised among them that the Ten Commandments were given by God from Mount Sinai, men would think they were at liberty to steal, and women would consider themselves absolved from the restraints of chastity." But his most distinguished effort at the bar was undoubtedly the speech for the House of Commons in the famous case of Stockdale *v.* Hansard. The Commons had ordered to be printed, among other papers, a Report of the Inspectors of Prisons on Newgate, which stated that an obscene book, published by Stockdale, was given to the prisoners to read. Stockdale sued the Commons' publisher, and was met by the plea of parliamentary privilege, to which, however, the judges did not give effect, on the ground that they were entitled to define the privileges of the Commons, and that publication of papers was not essential to the functions of Parliament. The matter was settled by the Act 3 Vict. c. 9.

In 1840 Campbell conducted the prosecution against John Frost, one of the three Chartist leaders who attacked the town of Newport, all of whom were found guilty of high treason. We may also mention, as matter of historical interest, the case before the High Steward and the House of Lords which arose out of the duel fought on Wimbledon Common between the earl of Cardigan and Captain Harvey Tuckett. The law of course was clear that the "punctilio which swordsmen falsely do call honour" was no excuse for wilful murder. To the astonishment of everybody Lord Cardigan escaped from a capital charge of felony because the full name of his antagonist (Harvey Garnett Phipps Tuckett) was not legally proved. It is difficult to suppose that such a blunder was not preconcerted. Campbell himself made the extraordinary declaration that to engage in a duel which could not be declined without infamy (*i.e.*, social disgrace) was "an act free from moral turpitude," although the law properly held it to be wilful murder. Next year, as the Melbourne administration was near its close, Plunkett, the venerable chancellor of Ireland, was forced by discreditable pressure to resign, and the Whig attorney-general, who had never practised in Equity, became chancellor of Ireland, and was raised to the peerage with the title of Baron Campbell of St Andrews, in the county of Fife. His wife, Mary Elizabeth Campbell, the eldest daughter of the first Baron Abinger by one of the Campbells of Kilmorey, Argyllshire, whom he had married in 1821, had in 1836 been created Baroness Stratheden. The post of chancellor Campbell held for only sixteen days, and then resigned it to his successor Sir Edward Sugden (Lord St Leonards). It was during the period 1841–49, when he had no legal duty, except the self-imposed one of occasionally hearing Scotch appeals in the House of Lords, that the unlucky dream of literary fame troubled Lord Campbell's leisure.[4] By two days' court work in Dublin

[1] A terminable estate in land, vested or continued in trustees, for convenience in giving security without exhibiting a title to the complete estate.

[2] If we may trust the scandalous chronicle of Greville, Campbell got this post on condition that he should not expect the ordinary promotion to the bench, a condition which he immediately violated by claiming the vice-chancellorship on the death of Sir John Leach. Pepys (Lord Cottenham) and Bickersteth (Lord Langdale) were both promoted to the bench in preference to Campbell.

[3] "There can be no doubt that old Wynton was at the bottom of it all, and persuaded Lord Grantley to urge it on for mere political purposes."—Greville, iii. 351.

[4] In 1842 he published the *Speeches of Lord Campbell at the Bar and in the House of Commons, with an Address to the Irish Bar as Lord Chancellor of Ireland.* (Edin., Black.)

he had received a pension of £4000 per annum from an ungrateful country, and he suddenly remembered what Lords Coke and Bacon had said about the debt due from every successful lawyer.

Following in the path struck out by Miss Strickland in her *Lives of the Queens of England*, and by Lord Brougham's *Lives of Eminent Statesmen*, he at last produced, in 1849, *The Lives of the Lord Chancellors and Keepers of the Great Seal of England, from the earliest times till the reign of King George IV.*, 7 vols. 8vo. The conception of this work is magnificent; its execution wretched. Intended to evolve a history of jurisprudence from the truthful portraits of England's greatest lawyers, it merely exhibits the ill-digested results of desultory learning, without a trace of scientific symmetry or literary taste, without a spark of that divine imaginative sympathy which alone can give flesh and spirit to the dead bones of the past, and without which the present becomes an unintelligible maze of mean and selfish ideas. A charming style, a vivid fancy, exhaustive research, were not to be expected from a hard-worked barrister; but he must certainly be held responsible for the frequent plagiarisms, the still more frequent inaccuracies of detail, the colossal vanity which obtrudes on almost every page, the hasty insinuations against the memory of the great departed who were to him as giants, and the petty sneers which he condescends to print against his own contemporaries, with whom he was living from day to day on terms of apparently sincere friendship. These faults are not so glaring in the lives of such men as Somers and Hardwicke, whom distance in time makes safe from personal jealousy; they are painfully apparent in the lives of Eldon, Lyndhurst, and Brougham, and they have been pointed out by the biographers of Eldon and by Lord St Leonards.[1] And yet the book is an invaluable repertory of facts, and must endure until it is superseded by something better. It was followed by the *Lives of the Chief Justices of England, from the Norman Conquest till the death of Lord Mansfield*, 8vo, 2 vols., a book of similar construction but inferior merit.

It must not be supposed that during this period the literary lawyer was silent in the House of Lords. He spoke frequently. The 3d volume of the *Protests of the Lords*, lately edited by Mr Thorold Rogers, contains no less than ten protests by Campbell, entered in the years 1842–45. He protests against Peel's Income Tax Bill of 1842; against the Aberdeen Act (6 and 7 Vict. c. 61) as conferring undue power on church courts; against the perpetuation of diocesan courts for probate and administration; against Lord Stanley's absurd bill providing compensation for the destruction of fences to dispossessed Irish tenants; and against the Parliamentary Proceedings Bill, which proposed that all bills, except money bills, having reached a certain stage, or having passed one House, should be continued to next session. The last he opposed because the proper remedy lay in resolutions and orders of the House. He protests in favour of Lord Monteagle's (Mr Spring Rice) motion for inquiry into the sliding scale of corn duties under 5 Vict. c. 14; of Lord Normanby's motion on the Queen's speech in 1834, for inquiry into the state of Ireland (then wholly under military occupation); of Lord Radnor's bill to define the constitutional powers of the home secretary, when Sir James Graham opened Mazzini's letters. In 1844 he records a solitary protest against the judgment of the House of Lords in Reg. *v.* Millis, which affirmed that a man regularly married according to the rites of the Irish Presbyterian Church, and afterwards regularly married to another woman by an Episcopally ordained clergyman, could not be convicted of bigamy, because the English law required for the validity of a marriage that it should be performed by an ordained priest.

On the resignation of Lord Denman in 1850, Campbell was appointed Chief Justice of the Queen's Bench. For this post he was well fitted by his knowledge of common law, his habitual attention to the pleadings in court, and his power of clear statement. On the other hand, at *Nisi Prius* and on the criminal circuit, he was accused of frequently attempting unduly to influence juries in their estimate of the credibility of evidence. It is also certain that he liked to excite applause in the galleries by some platitude about the "glorious Revolution" or the "Protestant succession."[2] He assisted in the reforms of special pleading at Westminster, and had a recognized place with Brougham and Lyndhurst in legal discussions in the House of Lords. But he had neither the generous temperament nor the breadth of view which is required in the composition of even a mediocre statesman. In 1859 he was made Lord Chancellor of Great Britain, probably on the understanding that Bethell should succeed as soon as he could be spared from the House of Commons. His short tenure of this office calls for no remark. In the same year he published in the form of a letter to Mr Payne Collier an amusing and extremely inconclusive essay on Shakespeare's legal acquirements. One passage will show the conjectural process which runs through the book: "If Shakespeare was really articled to a Stratford attorney, in all probability, *during the five years of his clerkship, he* visited London several times on his master's business, and he may then have been introduced to the green-room at Blackfriars by one of his countrymen connected with that theatre." The only positive piece of evidence produced is the passage from Thomas Nash's "Epistle to the Gentlemen of the Two Universities," prefixed to Greene's *Arcadia*, 1859, in which he upbraids somebody (not known to be Shakespeare) with having left the "trade of Noverint" and busied himself with "whole Hamlets" and "handfuls of tragical speeches." The knowledge of law shown in the plays is very much what a universal observer must have picked up. Lawyers always underestimate the legal knowledge of an intelligent layman. Campbell died on the 23d June 1861. It has been well said of him in explanation of his success, that he lived eighty years and preserved his digestion unimpaired. He had a hard head, a splendid constitution, tireless industry, a generally judicious temper. He was a learned, though not a scientific lawyer, a faithful political adherent, thoroughly honest as a judge, dutiful and happy as a husband. But there was nothing admirable or heroic in his nature. On no great subject did his principles rise above the commonplace of party, nor had he the magnanimity which excuses rather than aggravates the faults of others. His life is the triumph of steady determination unaided by a single brilliant or attractive quality. (W. C. S.)

CAMPBELTOWN, a royal burgh and seaport of Scotland, in Argyllshire, situated on an indentation of the coast, near the southern extremity of the peninsula of Kintyre, in 55° 25' N. lat. and 5° 36' W. long. Its principal buildings are the churches (one of which stands on the site of the castle of the Macdonalds), the town house, the jail, and the athenæum. The staple industry is the manufacture of whisky. There are in the town, or in

[1] It was of this book that Sir Charles Wetherell said, referring to its author, "and then there is my noble and biographical friend who has added a new terror to death." See *Misrepresentations in Campbell's "Lives of Lyndhurst and Brougham" corrected by St Leonards*, London, 1869.

[2] This applies particularly to his conduct of the case of [illegible] Dr Newman for libel contained in the *Lectures on the [illegible] of Protestantism*. See special *Report* by W. F. [illegible]

its immediate vicinity, upwards of twenty distilleries, which produce a spirit that is in high estimation. Many of the inhabitants are also engaged in the fisheries and the coasting trade. A good supply of water is furnished, from a distance of a mile and a half, by the works opened in 1866. The harbour, which is formed by the inlet of the sea called Campbeltown Loch, has been improved by the extension of the pier to a distance of 250 feet. The whole bay measures about 2 miles in length by 1 in breadth, and has from 6 to 15 fathoms water. The registered vessels belonging to the port on the 31st of December 1874 were 41 sailing vessels of 2590 tons and 2 steamships of 284. During the same year there entered 806 British and 18 foreign vessels, with a tonnage of 61,838 and 2353 respectively. Campbeltown unites with Ayr, Inveraray, Irvine, and Oban in sending one member to parliament. The population of the parliamentary burgh in 1871 was 4593, while that of the parish amounted to 8580. Campbeltown is supposed to be a place of considerable antiquity, though no memorial of this exists except a finely-sculptured stone cross, which now stands on a pedestal in the market-place, and is popularly assigned to the 12th century. Prior to 1700 the place was a mere fishing village, but it was then erected into a royal burgh through the interest of the Argyll family, from whom it derived its name.

CAMPE, Joachim Heinrich (1746–1818), a German educationist, was born at Deensen in Brunswick in 1746. He studied theology at the university of Halle, and after acting for some time as chaplain at Potsdam, he accepted a post as director of studies in the Philanthropin at Dessau. He soon after set up an educational establishment of his own at Trittow, near Hamburg, which he was obliged to give up to one of his assistants within a few years, in consequence of feeble health. In 1787 he proceeded to Brunswick as counsellor of education, and purchased the *Schulbuchhandlung*, which under his direction became a most prosperous business. He died in 1818. His numerous educational works were widely used throughout Germany. Among the most popular were the *Kleine Kinderbibliothek*, 12 vols., 11th ed., 1815; *Robinson der Jüngere*, 59th ed., 1861, translated into English and into nearly every European language; and *Sämmtliche Kinder- und Jugendschriften*, 37 vols.

CAMPEACHY, or Campeche, a fortified town of Mexico, formerly in the province of Yucatan, but now the capital of a new state to which it gives its name, is situated on the west side of the peninsula on the shore of the Bay of Campeachy, in 20° 5′ N. lat. and 90° 16′ W. long. The town is generally well built, though the houses, chiefly of limestone, are for the most part only one story in height. Its public edifices, several of which are substantial structures, comprise a citadel, several churches and convents, a theatre, a museum, a college, a school of navigation, a hospital, and a custom-house. The port, though of considerable extent, and defended by a breakwater 160 feet long, is very shallow, and vessels drawing more than 10 feet have to anchor upwards of a mile from shore. During the Spanish domination Campeachy had a monopoly of the imports to Yucatan, and it still maintains a fair amount of commercial activity. There is a large trade in logwood (*Palo de Campeche*, or Campeachy wood), and considerable quantities of wax, cotton, hides, and cigars are also exported. Shipbuilding is carried on, and salt and marble are obtained in the neighbourhood. In 1872, 24 foreign vessels entered the port, and 317 engaged in the coasting trade; and in the previous year the customs amounted to £29,133,000. A railway is in course of construction to Minatitlan, a distance of 385 miles. The vicinity is interesting for its Indian remains; and the city itself is said to be "built over extensive artificial galleries or catacombs, supposed to have been devoted by the ancient people [Mazas] to sepulchral uses." See Bancroft's *Native Races of the Pacific States of North America*, vol. iv. p. 265. The Spanish town, founded about 1540 near the older Indian settlement, which at the time of the conquest had about 3000 houses, was captured by the English in 1659, and several times in the same century fell into the hands of the Buccaneers. In the revolution of 1842 it was the scene of various engagements between the Mexicans and the people of Yucatan, in the last of which the latter were signally successful. The population, which numbered 15,500 in 1865, is now nearer 19,000.

CAMPEGGIO, or Campeggi, Lorenzo (1479–1539), Cardinal, was born at Bologna in 1479. He was the son of an eminent lawyer, and for some years was himself engaged in the legal profession. But after the death of his wife he entered the church and quickly attained to high office. For his services to the Papal cause during the reduction of Bologna, Pope Julius II. raised him to the rank of bishop, and sent him as nuncio to Germany and Milan. In 1517 he became cardinal, and two years later he was sent to England to stir up a religious crusade against the Turks. He was unsuccessful in this mission, but received from Henry VIII., in 1524, the bishopric of Salisbury. Towards the close of 1528 he came over to England to assist Wolsey with regard to Henry's contemplated divorce from Katherine. He failed to accomplish anything, and left in the following year. The bishopric of Salisbury was withdrawn from him, and though at a later date (1536) it seemed possible that he might regain it, his expectations were disappointed. He died at Rome in 1539, just as he was about to set out on an embassy to Vicenza.

CAMPER, Peter (1722–1789), a celebrated anatomist and naturalist, was born at Leyden, May 11, 1722. He was educated at the university of Leyden, and in 1746 graduated in philosophy and medicine. After the death of his father in 1748 he spent more than a year in England, studying under the most famous medical teachers in London. He then visited Paris, Lyons, and Geneva, and returned to Franeker, where he had been appointed to the professorship of philosophy, medicine, and surgery. He visited England a second time in 1752, and in 1755 he was called to the chair of anatomy and surgery at the Athenæum in Amsterdam. He resigned this post after six years, and retired to his country house near Franeker, in order uninterruptedly to carry on his studies. In 1763, however, he accepted the professorship of medicine, surgery, and anatomy at Groningen, and continued in the chair for ten years. He then returned to Franeker, and after the death of his wife in 1776 spent some time in travelling. He made the acquaintance of Diderot and Marmontel at Paris, and was received with great respect by Frederick the Great at Potsdam. In 1762 he had been returned as one of the deputies in the assembly of the province of Friesland, and the latter years of his life were much occupied with political affairs. In 1783 he was nominated to a seat in the council of state, and took up his residence at the Hague. His death (7th April 1789) was caused by a violent pleurisy, the effects of which were accelerated by political excitement.

Camper's works, mainly memoirs and detached papers, are very numerous; the most important of those bearing on comparative anatomy were published in three vols. at Paris in 1803, under the title *Œuvres de P. Camper qui ont pour objet l'Histoire Naturelle, la Physiologie, et l'Anatomie Comparée.*

CAMPERDOWN. See Duncan, Adam.

CAMPHOR is a colourless translucent body, having a tough waxy structure, with a specific gravity about equal to that of water, melting at 347° Fahr. and boiling at 400°. It volatilizes readily at ordinary temperatures

giving off that peculiarly pungent aromatic odour which is characteristic of the substance. It is very slightly soluble in water, to which it communicates its warm camphoraceous taste; but it dissolves with facility in alcohol, ether, fixed and volatile oils, naphtha, &c. In its chemical constitution it is analogous to the solid stearoptines deposited by many essential oils, especially such as are derived from labiate plants. By submitting it to the action of oxidizing agents camphor, $C_{10}H_{16}O$, is transformed into camphoric acid, $C_{10}H_{16}O_4$, and if the oxidation is continued it becomes camphretic acid, $C_{10}H_{14}O_7$.

The greater part of the camphor of Western commerce is obtained by distillation from the wood of a tree, *Camphora officinarum*, belonging to the Natural Order *Lauraceæ*. It is produced most largely in the Island of Formosa, the area of production being a narrow belt of debateable land separating the Chinese settlement from the territory held of the aboriginal inhabitants of the island. The preparation of the product is consequently attended with considerable danger, owing to the mutual jealousies and encroachments of the natives and the Chinese. The crude and primitive process of distillation is thus described by Mr E. C. Taintor in his *Trade Report of Tamsui*, 1869:—"A long wooden trough, frequently hollowed out from the trunk of a tree, is fixed over a furnace and protected by a coating of clay. Water is poured into it, and a board perforated with numerous small holes is luted over it. Over these holes the chips [of the camphor-wood] are placed and covered with earthenware pots. Heat being applied in the furnace, the steam passes through the chips, carrying with it the camphor, which condenses in the form of minute white crystals in the upper part of the pots." It is collected and stored in vats to await exportation, during which time it gives out from 3 to 4 per cent. of uncrystallizable camphor oil of a yellowish colour, which has been suggested for use in medicine and the arts in the same way as spirits of turpentine. In addition to the supplies obtained from Formosa, a considerable quantity of camphor is now shipped from Japan. Japanese unrefined camphor is of a lighter colour than that obtained from Formosa, and commands a higher price in the market. Crude camphor is submitted to a process of refining by sublimation from a small quantity of sand, charcoal, iron-filings, or lime. The operation is conducted in glass vessels of peculiar form, to the upper part of which the sublimate adheres. It requires to be conducted with great care on account of the peculiarly inflammable nature of the product, and the heat must be carefully regulated to produce a solid compact cake.

Borneo camphor, or Barus camphor, is a variety differing entirely in its source, being the produce of *Dryobalanops Camphora*, and also somewhat removed in its chemical constitution and physical properties from the ordinary variety. It is obtained in its concrete form in fissures in old trees, which are cut down and split up in search of it. The tree is a native of the Malay peninsula, and is found chiefly in certain parts of Borneo and Sumatra. Borneo camphor is extravagantly prized by the Chinese, who readily pay one hundred times more for this variety than for ordinary camphor.

A third variety of camphor, scarcely known beyond China, but there called Ngai camphor, has been ascertained by the late Mr D. Hanbury to be the product, in part at least, of *Blumea balsamifera*. In chemical composition it is the same as Borneo camphor, but differs from it in respect of odour, greater hardness, and higher volatility. In China it occupies in respect of value an intermediate place between ordinary and Borneo camphor.

Camphor is extensively employed in medicine both internally and externally as a stimulant, but its chief medicinal use is in the preparation of liniments, into the composition of many of which it enters. It has a vulgar reputation as a prophylactic, on which account it is in great demand during serious epidemics. It possesses properties invaluable to naturalists and others for keeping furs, skins, and other animal substances free from moths; and it similarly preserves cabinets of insects from attack. A very large quantity of camphor is consumed in India, and generally throughout the East.

CAMPHUYSEN, Dirk Rafaelsz (1586–1627), a Dutch painter, poet, and theologian, the son of a surgeon at Gorcum, was born in 1586. As he manifested great artistic talent, his brother, in whose charge he was left on the death of his parents, placed him under the painter Govitz. But at that time there was intense interest in theology; and Camphuysen, sharing in the prevailing enthusiasm, deserted the pursuit of art, to become first tutor of the sons of the lord of Nieuport, and then minister of Vleuten. As, however, he had embraced the doctrines of Arminius with fervour, he was driven from this post, and suffered much persecution. His chief solace was poetry; and he has left a translation of the Psalms, and a number of short pieces, remarkable for their freshness and depth of poetic feeling. He is also the author of several theological works of fair merit, among which is a *Compendium Doctrinæ Socinorum*; but his fame chiefly rests on his artistic power. His pictures, like his poems, are mostly small, but of great beauty; the colouring, though thin, is pure; the composition and pencilling are exquisite, and the perspective above criticism. The best of his works are his sunset and moonlight scenes and his views of the Rhine and other rivers. The close of his life was spent at Dokkum, where he died in 1627.

CAMPI, Bernardino, a pupil of Giulio Campi, who adopted a less ambitious style, but is equal and in some respects superior to his master. Bernardino was born at Cremona in 1525, and began life as a goldsmith. After an education under Giulio Campi and Ippolito Corta, he attained such skill that when he added another to the eleven Cæsars of Titian, it was impossible to say which was the master's and which the imitator's. He was also much influenced by Correggio and Raffaelle.

CAMPI, Giulio, the founder of a school of Italian painters, was born at Cremona about 1502, and died in 1572. He was son of a painter, Galeazzo Campi, under whom he took his first lessons in art. He was then taught by Giulio Romano; and he made a special study of Titian, Correggio, and Raffaelle. His works are remarkable for their correctness, vigour, and loftiness of style. They are very numerous, and the church of St Margaret in his native town owes all its paintings to his hand. Among the earliest of his school are his brothers, Vincenzo and Antonio, the latter of whom was also of some mark as a sculptor and as historian of Cremona.

CAMPIAN, Edmund (1540–1581), a celebrated English Jesuit, was born of humble parentage at London in 1540. From Christ's Hospital he removed to Oxford University, where he took a degree and became fellow of St John's. He was admitted to holy orders in the English Church, and in 1567 was ordained deacon. Being convinced that he could not assent to the Protestant formulary required by the Church of England, he left Oxford and went to Ireland, where he occupied himself in writing a history of the country. He then joined Allen and others at Douay, and passed his novitiate as member of the Society of Jesus. After residing for a short time at Brünn, Vienna, and Prague, where he taught philosophy and rhetoric, he was sent by Gregory XIII., along with Father Parsons, on a propagandist mission to England. He arrived in England in 1580, and entered on his duties by challenging the

universities and clergy to dispute with him. In July 158; he was apprehended along with Parsons and two other agents at Lyford in Berks, and thrown into the Tower, on a charge of having excited the people to rebellion, and holding treasonable correspondence with foreign powers. Having been found guilty, he was condemned to death, and was executed at Tyburn, Dec. 1, 1581, with several others of his order. He is admitted to have been a man of great abilities, an eloquent orator, a subtle philosopher, and able diplomatist; and he is praised by all writers, whether Protestant or Roman Catholic, not only for his talents and acquirements, but also for the amiability of his disposition. A full account of the Jesuit mission in which Campian took part will be found in Froude's *History of England*, vol. xi.

CAMPLI, a town of Italy, in the province of Abruzzo Ulteriore I., 5 miles north of Teramo. It has a cathedral, an abbey, and several churches and convents. Population, 7770.

CAMPOBASSO, a city of Italy, the capital of the province Molise, 53 miles N.N.E. of Naples. It is situated on the ascent of the mountain Monteverde, around which it forms a kind of amphitheatre. It is fortified, and contains a cathedral, the ruins of a castle, a small theatre, a hospital, and various other public buildings. The most important industry is the making of steel and cutlery, and there is a considerable export trade in corn. Population, 14,090.

CAMPOBELLO, a town of Sicily, in the province of Trapani, 7 miles E.S.E. from Mazzara. In the neighbourhood are the interesting quarries of Rocca di Cusa, from which the blocks were obtained for the buildings of the ancient Selinus. Population, 5575.

CAMPOBELLO DI LICATA, a town of Sicily, in the province of Girgenti, and 20 miles E.S.E. of the city of that name, on a tributary of the Salso. It possesses valuable sulphur mines. Population, 6301.

CAMPOMANES, Pedro Rodriguez, Conde de (1710–1802), a Spanish statesman and writer, was born in Asturias about 1710, or, according to other authorities, in 1723. From 1788 to 1793 he was president of the council of Castile; but on the accession of Charles IV. he was removed from his office, and retired from public life, regretted by the true friends of his country. His first literary work was *Antiquidad Maritima de la Republica de Cartago*, with an appendix containing a translation of the *Voyage of Hanno* the Carthaginian, with curious notes. This appeared in a quarto volume in 1756. His principal works are two admirable essays, *Discurso sobre el Fomento de la Industria Popular*, 1774, and *Discurso sobre la Educacion Popular de los Artesanos y su Fomento*, 1775. As a supplement to the last, he published four appendices, each considerably larger than the original essay. The first contains reflections on the origin of the decay of arts and manufactures in Spain during the last century. The second points out the steps necessary for improving or re-establishing the old manufactures, and contains a curious collection of royal ordinances and rescripts regarding the encouragement of arts and manufactures, and the introduction of foreign raw materials. The third treats of the guild laws of artisans, contrasted with the results of Spanish legislation and the municipal ordinances of towns. The fourth contains eight essays of Francisco Martinez de Mata on national commerce, with some observations adapted to present circumstances. These were all printed at Madrid in 1774 and 1777, in five volumes. Count Campomanes died in 1802.

CAMUCCINI, Vincenzo (1775–1844), the most famous of the modern historical painters of Italy, was born at Rome in 1775. He was educated by his brother Pietro, a picture

restorer, and Bombelli, an engraver, and, up to the age of pa..irty, attempted nothing higher than copies of the great worksters, his especial study being Raffaelle. As an original care thr, Camuccini belongs to the school of David. His essentia are rather the fruits of great cleverness and patient both person of fresh and original genius; and his style was and prefer.v imitative. He enjoyed immense popularity, He was appually and as an artist, and received many honours and of the Nheuts from the Papal and other Italian courts. of the pictures pinted director of the Academy of San Luca of nearly all the eapolitan Academy at Rome, and conservator of Honour. His of the Vatican. He was also made chevalier the Assassination orders in Italy, and member of the Legion Devotion of the chief works are the classical paintings of Remus, Horatius Cocle of Cæsar, the Death of Virginia, the in mosaic for St Peter Roman Women, Young Romulus and Temple, and a number s, the St Thomas, which was copied Rome September 2, 1844 s, the Presentation of Christ in the f excellent portraits. He died at

CAMUS, Charles Et...

French mathematician and m...enne Louis (1699–1768), a en-Brie, near Meaux, on the echanician, was born at Crécy-age of twelve he was able to m p 25th August 1699. At the at the Collége de Navarre in ssf aintain himself by teaching himself to mathematics, civil a in , Paris, where he devoted astronomy. He became Ass se of nd military architecture, and Sciences, professor of geomet with ociate of the Académie des of Architecture, and memb rine. ry, secretary to the Academy London. In 1736 he acc owing r of the Royal Society of Clairvaut in an expedition to L m h ompanied Maupertuis and of a degree of the meridian, the apland for the measurement service, not only as a geometric l. H when he rendered essential by his remarkable skill in the t on ian and astronomer, but also on the 2d February 1768. He 789), mechanical arts. He died *de Mathématiques* (Paris, 1766), a eyder was the author of *a Cours* mathematical and mechanical subj y of L d a number of essays on medicin ects.

CANA, of Galilee, a village more th of Palestine, remarkable as the birthplace of Nathanael, and the scene of Christ's "beginning of miracles." Its ex mous act site is unknown, but it is evident from the Biblical nar s, Lyo ative that it was in the neighbourhood of Capernaum. By a d be tradition as old as the 8th century it is identified with *Kefr Ke ine*, 52, a na, and by a more modern hypothesis with *Kana-el-Jelil*. nd s The former lies about 4½ miles N.W. of Nazareth, and cont *this p* ains the ruins of a church and a small Christian population; Fra the latter is an uninhabited village about 9 miles N. of Naza In eth, with no remains of antiquity but a few cisterns. surge

CANAAN, a geographical name of archaic Hebre r for origin, generally supposed to mean "depression," "lowland," he and hence fitly applied to various low-lying *districts* of Syria, viz., Phœnicia (Isa. xxiii. 11; Josh. v. *1*, *where the* LXX. has τῆς Φοινίκης), Philistia (Zeph. ii. 5), and the valley of the Jordan (as implied in Num. xiii. *29*, *cf.* Josh. xi. 3). It is, however, also applied to *the whole* of the territory conquered by the Israelites on the west side of the Jordan (Gen. xi. 31, xii. 5; Num. xiii. *2*, *17*, *&c.*), the boundaries of which are given in Gen. xv. *18 as* "the river of Egypt," (*i.e.*, the Wâdy, or torrent-valley, el-Arîsh), and "the great river," the River Euphrates. Probably the Israelites found the name in use in the *Jordan* Valley, and, as a part of this was the first district they conquered, extended it to their subsequent acquisitions. We have good parallels for this extension in the use of Argos for the whole of the Peloponnese, and of Hellas for the mainland of Greece. Of course this theory implies that the original signification of the word had been forgotten as was so often the case with Hebrew proper names. The Phœnicians likewise accepted the name of Canaan. Hecatæus of Miletus (about 520 B.C.) knew Χνᾶ as a

synonym for Φοινικη, and the same identification is found in Philo's *Sanchoniathon* (Müller's *Fragmenta Hist. Græc.*, vol. i. p. 17, vol. iii. p. 369). St Augustine, too, says that the Punic peasants, when asked what they were, replied in Punic, *Chanani* (ed. Bened., vol. iii. col. 932), and on a coin of the date of Antiochus Epiphanes, Laodicea in the Lebanon district is called "a mother, or metropolis, in Canaan" (see inscription in Schröder, *Die phönizische Sprache*, p. 275). It is remarkable that there is a trace, and no more, of the extended use of the word Canaan in Egyptian. The town nearest to Canaan, in the territory of the Shasu or Bedawín (*lit.* Brigands, *cf.* Heb. *shāsūh*), was called Pa-Kanana (Brugsch, *Histoire d'Égypte*, p. 145).

An instance of the confusion produced by the different uses of the term Canaan is supplied by Gen. x. 15–18, where the list of Phœnician cities is interrupted by the five Palestinian nations, the Hittites, Jebusites, &c. As De Goeje has pointed out, the original writer of the Table of Nations understood Canaan in the sense of Phœnicia—he had probably used a Phœnician chart; the interpolator, in that of Palestine (*Theologisch Tijdschrift*, 1870, p. 241).

Why Canaan is placed among the descendants of Ham could only be shown by a chart of the world as known to the Phœnicians. Clearly there was a misunderstanding as to the coasts of the Red Sea.

Compare Movers, *Die Phönizier*, vol. ii. (1), pp. 4–6; Knobel, *Die Völkertafel der Genesis*, pp. 307–310; De Goeje, *Over de Namen Phoenicië in Kanaän*, Amst. 1870. (T. K. C.)

CANAANITES. Only two of the possible senses of the word Canaanite need be here referred to; for the others, see PHŒNICIANS and PHILISTINES. And as one of these is included in the other, let us pass at once to the Canaanites in the larger sense, *i.e.*, the whole group of nations conquered by the Israelites on the west side of the Jordan. The group is variously described. It is sometimes said to consist of five—Canaanites, Hittites, Amorites, Hivites, Jebusites (Exod. xiii. 5); sometimes of six, the Perizzites, *i.e.*, *Pagani*, being added (Exod. iii. 8, 17, xxiii. 23, xxxiii. 2, xxxiv. 11; Deut. xx. 17; Josh. ix. 1, xii. 8); sometimes of seven, by including the Girgashites (Deut. vii. 1; Josh. iii. 10, xxiv. 11); once of ten, omitting the Hittites, and including the aboriginal Rephaim and three Arab tribes, the Kenites, Kenizzites, and Kadmonites (Gen. xv. 19–21). The latter, however, are clearly inserted by mistake, as they only became inhabitants of Palestine, so far as they did become such, as the reward of assistance given to the Israelites. There are only two of these nations about whom we have any collateral information—the Hittites and the Amorites. The former, however, seem also to have been included among the Canaanites by mistake. Historical evidence, both Biblical and extra-biblical, proves convincingly that they dwelt beyond the borders of Canaan; and linguistic evidence tends on the whole to show that they did not even speak a Semitic language (see HITTITES). The latter, too, were not entirely homogeneous with the other Canaanitish peoples, if the notices in Deut. iii. 11 ("Og . . . of the remnant of the Rephaim"), *ibid.* 13; Josh. xii. 4, xiii. 12, may be taken as historical. Perhaps, as Ewald suggests, they were mixed with the aborigines. A Semitic basis seems probable, but has only one linguistic fact in its favour—Senir, the Amorite name of Hermon (Deut. iii. 9), mentioned also in an inscription of Shalmaneser (*Brit. Mus. Coll.*, vol. iii. p. 5, No. 6, l. 45); personal names like Og and Sihon may easily have been Semiticized, and the name Amorite itself, being probably descriptive (see AMORITES), has no ethnological value. They are at all events un-Canaanitish in their political capacity, two considerable states having been founded by them on the east of the Jordan (Deut. iii. 8; Josh. xii. 2; Judg. x. 8, xi. 22). It will therefore be better to exclude Hittites and Amorites from the present notice.

I. It is extremely difficult to draw any distinction between the remaining members of the Canaanitish group. As described in the early books of the Old Testament, they have a general family likeness. They are described as living in a state of political disintegration, the combined result of the Semitic love of independence and of the varied conformation of the soil. Thirty-one of their petty kings are mentioned in Josh. xii. 9–24, including the king of Hazor (afterwards reckoned to Naphtali), whose realm, in Judg. xi. 10, is called "the chief of all those kingdoms." We find, indeed, a king of Bezek claiming to have enslaved "seventy" of the surrounding *reguli* (Judg. i. 7), but this is an altogether exceptional event, for which the loosening of authority produced by the guerilla warfare of the Israelites sufficiently accounts. Yet the isolation of the Canaanites can never have been complete. Like the Phœnicians, they will have had their federations, as appears to be implied by the title Baal-berith, or "Baal of the Covenant" (Judg. viii. 33); and hieroglyphic inscriptions tell of their alliances with the Khita or Hittites against their Egyptian suzerains. Indeed, the rebellious tendencies of the Syrian states will partly explain the inaction of the Pharaohs during the Israelitish conquest. The only injury Joshua could do to the latter would consist in blocking up the military coast-road to the north of Syria, but this was well secured by Egyptian garrisons, which Joshua did not venture to attack; while to get the Canaanites humbled without any trouble was a clear gain. That the Israelites were not immediately and at all points successful is now universally recognized. The work of many years was concentrated by tradition on a single great name; yet the Old Testament itself corrects by numberless indications the error of the more imaginative narrative. Thus the kingdom of Hazor, which had been utterly destroyed, according to Josh. xi. 10, 11, emerges again in the more accurate account of Judges (iv. 2, 3). And both Joshua and Judges (not to descend later—see AMORITES) supply evidence for the continued Canaanitish occupation of many parts of the country (Josh. xiii. 13, xv. 63, xvi. 10, xvii. 12, 13; Judg. i. 19–36). The immediate result of the invasion was, not the extinction of the old, but the addition of a new (and yet not wholly new) element, of stronger stuff but less advanced culture.

Political state.

II. No doubt the Israelites at first put an end to much of which they could not discern the value, or, to use their own phrase, made it a *khérem*, a thing consecrated to God by destruction. The origin of Hebrew literature would not be such a blank if the sacred archives of Kiryath-sépher, or "the Book-city," otherwise called Kiryath-sannah, or "the Law-city (?)" (Josh. xv. 15, 49), had been preserved. Still the attractions of culture were superior in the long run to the dictates of religious zeal. Goodly houses, vineyards, and oliveyards (Deut. vi. 10, 11) were agents more powerful even than chariots of iron. The secrets of agriculture had to be learned from the Canaanites; intercourse naturally led to intermarriage, and so a new strife arose in the field of religion, in which half the Jewish nation perished utterly, and the other half was only saved by its voluntary submission to a spiritual despotism.

Results of the conquest.

III. The pages of the book of Judges are full of complaints of Israelitish infidelity, which is rightly ascribed by the compiler to mixture of blood (Judg. iii. 6). It is true that expressions like this of infidelity have only a limited accuracy. As Ewald and Kuenen have pointed out, the final editor of Judges lived in the age of the Exile, when the religion of Yahveh (miscalled Jehovah) had attained its full development. From his point of view, religious approximation to the Canaanites was wilful apostasy, because it involved the effacement of the distinction between physical and moral religion. But of this distinction the Israelites were hardly more conscious than the Canaanites.

[illegible]

The religions of both nations were based on a feeling for the powers of nature, whether regarded as destructive and awful, as by the one, or as favourable and lovely, as by the other. Thus the one religion was stern and in tendency moral: the other soft and in tendency immoral: there was indeed a difference, but not a clear-cut distinction between them. To come to particulars,—the chief object of Canaanitish worship was the dual-natured god of life and fruitfulness, viz., Baal, or rather the Baal, *i.e.*, "the lord," and his consort Ashérah, *i.e.*, "the happy," and so "happy-making, favourable" (as in Assyrian, Salmanuâsir, "Salman is favourable"). The masculine form is also probably a divine title, and has given its name to the tribe of Asher, as Gad ("good fortune") to the Gadites. As Movers long ago pointed out, Ashérah is not identical with Ashtoreth or Astarte, whose name is philologically different, and who belongs to another type of Semitic religion. Her symbol was the stem of a tree (Deut. xvi. 21; Judg. vi. 25), though this may have been sometimes carved into an image; that of the Baal probably had the form of a cone, and represented the rays of the sun. It is these symbols which are referred to in the phrase, "the Baals and the Ashérahs" (Judg. iii. 7); the "groves" of the authorized version is an evident mistranslation (see in the Hebrew or some accurate modern version, Judg. vi. 25; 1 Kings xv. 13; 2 Kings xxiii. 6). The licensed harlotry which formed part of the worship of Ashérah was profoundly obnoxious to the later Hebrew writers (Num. xxv.; Deut. xxiii. 18), though, indeed, even the folk-lore of the Israelites shows traces of aversion to its attendant immorality. An illustration of this is furnished in the narrative of Sodom (Gen. xviii., xix.), which can only refer to the later Canaanites. Similarly, another writer (Gen. xv. 16) describes "the iniquity of the Amorites" as the divine justification of the Israelitish conquest. It is also the subject of a threatening passage in the Levitical legislation (Lev. xviii.), which if composed during the Babylonian exile, as is held by Graf and Kalisch, is a remarkable evidence of the tenacity of pre-Israelitish customs.

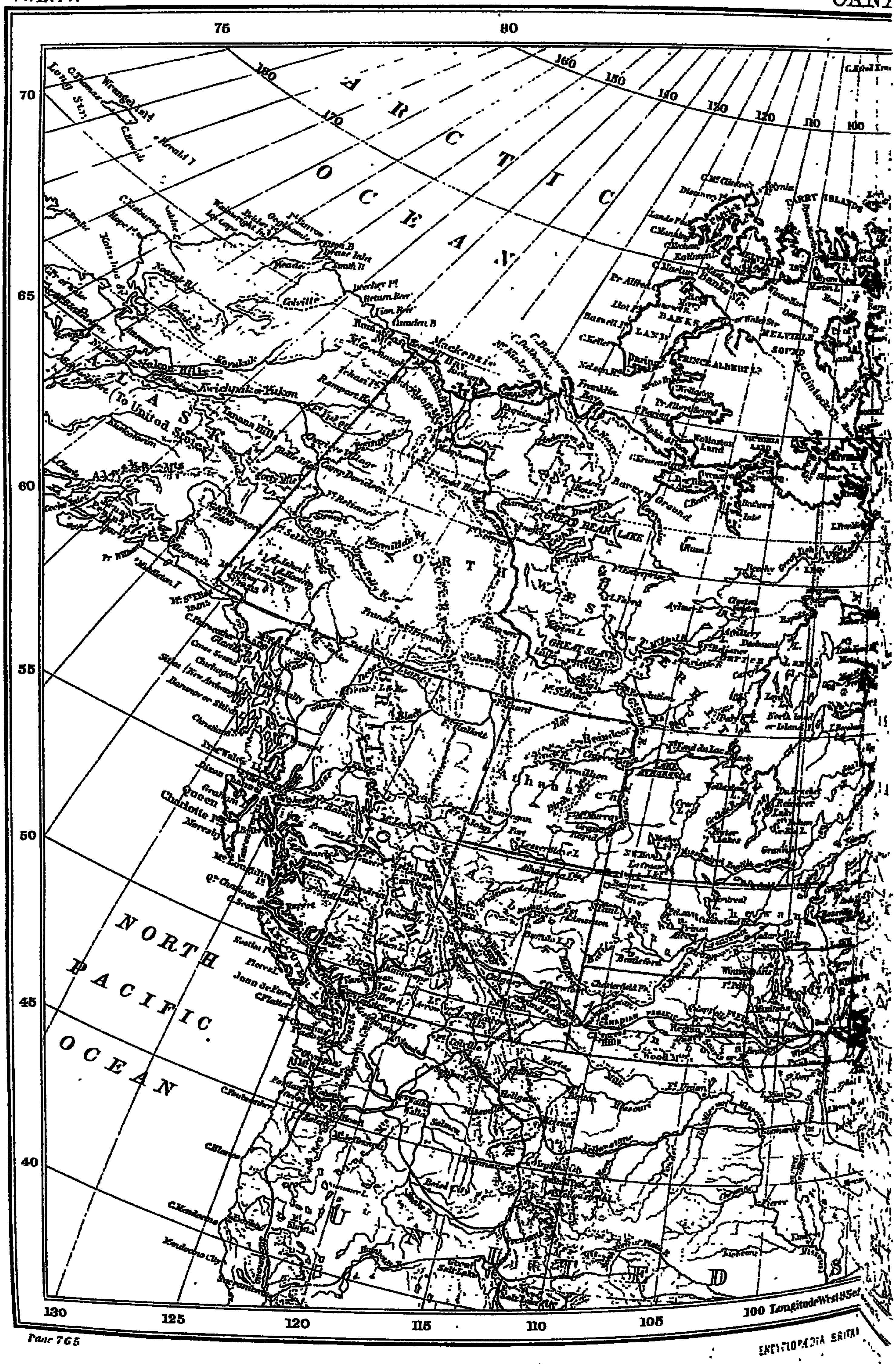
Another characteristic of Canaanitish religion, though far from peculiar to this, was soothsaying. After Israelite prophecy had broken its shell, and taken its daring flight into a more spiritual region, its first anxiety was to destroy that rival phenomenon which enslaved the minds of men to gross superstition. Hence the earnest dehortations of Isaiah (ii. 6), and of the writer of Deuteronomy (xviii. 10–14).

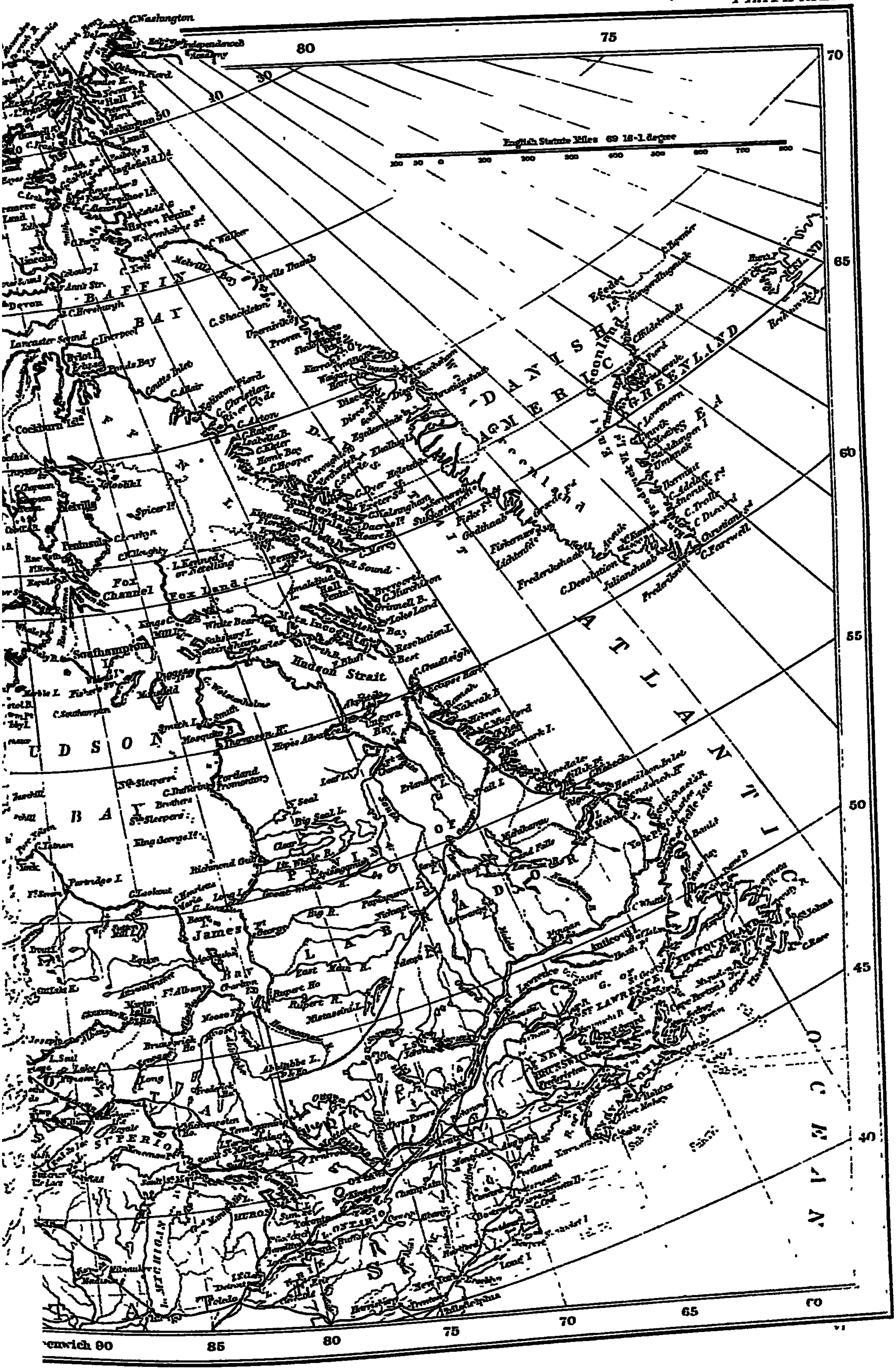
There was only one relic of Canaanitish times which the disciples of prophetic religion could not or would not throw aside—the old traditions. For it can hardly be doubted by uncompromising historical critics that some, perhaps many, of the narratives of Genesis are but purified versions of Canaanitish myths and legends. The most obvious examples will naturally be those stories which are attached to localities in Canaan, *e.g.*, Luz and Beersheba. Of course the story of Melchizedek, "the king of Salem," and "priest of the most high God" (Gen. xiv. 17–24), is not one of these, being out of harmony with all our other notices of the Canaanites. It is also easily separable from the rest of the narrative, and may possibly be as late as the Maccabean period, and written in honour of the temple and its priesthood, which are glorified by being, as it were, prefigured in the patriarchal age.

IV. The question has been asked of late, whether a remnant of the old population of Palestine may not still be in existence. M. Clermont-Ganneau, following Prof. E. H. Palmer (*History of the Jewish Nation*, p. 64), answers it confidently in the affirmative. In the fellahín or peasants of the Holy Land he sees the descendants of the Canaanites, who, having been reduced to a state of serfdom, were contemptuously overlooked by the successive hordes of conquerors. Their strange superstitious customs have been remarked by every close observer, and are evidently survivals of some early form of religion. M. Ganneau also mentions some curious legendary parallels to Biblical narratives existing among them. Dr Thomson (*The Land and the Book*, pp. 226-8) holds a similar theory about the sect of the Nusairíeh in northern Syria, who are equally bad Moslems, but more probably represent the *débris* of the later Syrian paganism.

V. We have yet to speak of the ethnological relation of the Canaanites and the Israelites. The linguistic evidence points to a kinship as close as that of both to the Phœnicians. Not only are the personal names of the Canaanites (Melchizedek, Adonibezek, Adonizedek, Ornan or Aranyah, of which Araunah seems to be a corruption) pure Hebrew, but so too are the names of their cities, an evidence of still greater value, as given both in the Old Testament and in the lists of the places conquered by Thothmes III. The latter have been discovered by Mariette-Bey on a kind of triumphal arch at Karnak; they include 119 names belonging to Canaan, of which 75 have been identified with known Hebrew names of places (Mariette-Bey, in *Comptes Rendus de l'Académie des Inscriptions*, 1874, p. 243, &c.). The same Hebraic character is apparent in the names given in the "Travels of a Mohar" (see the *Records of the Past*, vol. ii. pp. 107–116), which have been illustrated, we understand, by the recent explorations of Lieutenant Conder. How, it has been asked, is this community of language to be accounted for? The problem is a real one to those who regard the Table of Nations (Gen. x.) as an ethnological authority, for in that document the Canaanites are classed separately from the Hebrews among the descendants of Ham. From this, as we believe, antiquated point of view, it becomes necessary to assume that the Canaanites borrowed their language from some of the genuine descendants of Shem. From the Israelites? But they spoke the language long before the Israelite immigration. From an aboriginal Semitic-speaking race? But there is no historical evidence for the existence of such a people. We are thus driven to accept the view that the Table of Nations is arranged not on an ethnological but on a geographical principle. The Canaanites will then be classed among the descendants of Ham as belonging, according to the compilers, to the southern terrestrial zone—not, however, the Canaanites, in our sense of the word, for these formed no part of the original Table (see CANAAN), but the Phœnicians. Apart from this misunderstood document there is no difficulty in admitting the affinity of the three nations, the Israelites, the Canaanites, and the Phœnicians, who all appear to have migrated successively from a Babylonian centre (see PHŒNICIANS). The last to move westward were probably the Hebrews. They are generally supposed to have originally spoken an Aramaic dialect, but after entering Palestine to have adopted that of the more civilized Canaanites (see *Introductions* of Bleek and De Wette-Schrader). The only evidence, however, offered in support of this view is Gen. xxxi. 47, where the "cairn of witness" receives a Hebrew name from Jacob, an Aramaic from Laban. From this it is inferred that Laban's great-uncle Abraham must, according to tradition, have spoken Aramaic, as if Aramaic were as early a development as Hebrew, and as if the writer in Genesis had any thought of illustrating philological problems! Of any such event in the history of the Hebrews we have simply no evidence whatever.

Compare Ewald, *History of the People of Israel*, Eng. trans., vol. i. pp. 232–242; Kuenen, *Religion of Israel*, Eng. trans., vol. i. chap. 1 (with note) and 4; Movers, *Die Phönizier*, vol. ii. (1), pp. 61–82; Knobel, *Die Völkertafel der Genesis*, pp. 202, 321, 332–338; Clermont-Ganneau, "The Arabs in Palestine," in *Macmillan's Magazine*, August 1875. (T. K. C.)


A R C T I C
O C E A N
PARRY ISLANDS
BANKS LAND
PRINCE ALBERT LAND
MELVILLE SOUND
Wollaston Land
GREAT BEAR LAKE
GREAT SLAVE LAKE
LAKE ATHABASCA
Kwichpak or Yukon
(To United States)
Queen Charlotte Is.
N O R T H
P A C I F I C
O C E A N
100 Longitude West


BAFFIN BAY
DANISH AMERICA
GREENLAND
DAVIS STRAIT
ATLANTIC OCEAN
HUDSON BAY
LABRADOR
Hudson Strait
Fox Channel
Cumberland Sound
James Bay
G. OF ST LAWRENCE
NEWFOUNDLAND
L. ONTARIO
C. Farewell
Lancaster Sound
Southampton I.
English Statute Miles 69 18 = 1 degree
Greenwich 90
85
80
75
70
65
60
55
50
45
40

CANADA

Plate XXXV.

CANADA, geographically and politically, differs widely from the British colony known by that name prior to 1867. Before that date the country embraced under the name of Canada included a region about 1400 miles in length and from 200 to 400 miles in breadth, extending from the watershed west of Lake Superior eastward to Labrador. Alongside of it lay the independent British provinces of Nova Scotia, New Brunswick, Prince Edward Island, and Newfoundland, and beyond it to the north and the west the vast regions abandoned to the Hudson's Bay Company But various causes combined to impress on Canadian statesmen the desirableness of uniting the colonies of British North America into one political confederation.

On the cession of Canada to Great Britain in 1763, its French colonists were guaranteed the free exercise of the Roman Catholic religion, and equal civil and commercial privileges with British subjects. Further privileges were secured by "the Quebec Act" of 1774, whereby the old French laws, including the custom of Paris, the royal edicts, and those of the colonial intendants under the French regime, were declared binding in relation to all property and civil rights; while the criminal law was superseded by that of England with its trial by jury. The seignories, with their feudal rights and immunities, were also perpetuated; and thus, under the fostering protection of England, the colonial life of the France of Louis XV. and the regency survived in the "New France" of Canada, unaffected by the Revolution of 1792. But the whole French population at the date of the conquest did not exceed 65,000. From Great Britain, and still more from the older colonies, emigrants hastened to occupy the new territory to the north of the St Lawrence. On the declaration of independence by the revolted colonies in 1776, the loyalist refugees were welcomed by the Provincial Government, settled on land in Upper Canada, and aided with funds and farming implements; and these were followed by emigrants from Great Britain. But it was not till 1791 that the rule of a governor, aided solely by a council appointed by the Crown, was superseded by the grant of a constitution establishing the Government with an elective legislature. At the same time Upper Canada, with its purely British settlers, was made a separate province from the old French colony of Lower Canada. At this date the population of Lower Canada had increased to upwards of 130,000, and that of Upper Canada was about 50,000. According to the first strictly reliable census of 1811 it amounted to 77,000. But the increase of population of Lower Canada was in part due to the immigration of British settlers. In 1793 a Protestant bishop of Quebec was appointed by the home Government; and in 1804 a cathedral was erected for him at Quebec, on the site of the old Recollet church. Dr Jacob Mountain, the Anglican bishop, exerted himself in the cause of education. Parliament enacted the establishment of free schools throughout the parishes of Lower Canada, but to this the Roman Catholic clergy gave resolute opposition: and in various other ways a spirit of antagonism began to manifest itself between the French inhabitants and the British population.

The war of 1812 followed; and during the protracted struggle on the Canadian frontier till the signing of the treaty of Ghent in 1814, the French and British colonists were united in loyalty to England; but with the restoration of peace internal political difficulties revived. The legislative and executive councils were at open variance with the popular representative assemblies; and a new element of strife created antagonism between Upper and Lower Canada. The position of Quebec and Montreal gave to Lower Canada a control over the exports and imports of the country; financial misunderstandings arose between the two provinces respecting their rightful share of import duties; and a proposal, first made in 1822, for a legislative union between Upper and Lower Canada, was at length carried out in 1841, accompanied by important concessions designed to confer on the majority of the representatives of the people that influence over the executive Government which constituted the essential element of responsible government in England. But while the British colonists were divided by the old English party lines, the French Lower Canadians, united by local interests, race, and religion, were able to hold the balance of power whenever the two British parties divided on points of sufficient importance to preclude a compromise. Thus while the advantages of soil and climate, the industry, and the consequent wealth of Upper Canada, enabled it to contribute an ever-increasing proportion of the revenue of the united provinces, it frequently received a very partial share in their distribution, and was liable to be outvoted on questions in which both local feeling and local interests were largely involved. This condition of things was turned to account in the party contests of the time with an ever-increasing irritation and sense of wrong on the part of the British colonists of Upper Canada, until a common feeling overrode party lines, and matters were brought practically to a deadlock.

This it was which led to the idea of a legislative union among the various British American colonies, while reserving to each the control of its own local government; and the common dangers to which they were exposed by results springing out of the great American civil war furnished additional motives to such a union. The leaders of different parties representing the various interests of the provinces, after mature deliberation, agreed to the principles of the proposed confederation, and the Imperial Government responded by giving it the requisite force of parliamentary authority. The Imperial Act, known as "the British North American Act, 1867," provided for the voluntary union of the whole of British North America into one legislative confederation, under the name of the Dominion of Canada. Thus the older provinces have preceded, even by centuries, the Dominion within which they are now embraced, and have a separate history of their own. The Dominion thus constituted consists at present of the old provinces of Upper and Lower Canada, now designated respectively Ontario and Quebec, along with Nova Scotia, New Brunswick, Prince Edward Island, Manitoba, and British Columbia. To it also pertain the territories in the north-west still unsettled, with power to receive them into the confederacy when they acquire the requisite population and organization of provinces. Provision is also made in the Imperial Act for the admission of Newfoundland into the confederacy. It is further provided that the constitution of the Dominion shall be "similar in principle to that of the United Kingdom;" that the executive authority shall be vested in the sovereign of Great Britain and Ireland, and carried on in his name by a governor-general and privy council; and that the legislative power shall be exercised by a parliament consisting of an Upper House, or "Senate," the members of which are nominated for life, by summons under the great seal of Canada, and a "House of Commons," duly elected by the several constituencies of the various provinces in proportion to the relative population of each.

The Act of Confederation came into operation on the 1st of July 1867, at which date the provinces of Ontario and Quebec were united to the maritime provinces of Nova Scotia and New Brunswick. In 1870 the newly created province of Manitoba, in 1871 that of British Columbia, and in 1872 that of Prince Edward Island, were successively admitted into the confederation. A lieutenant-governor and council are to be appointed to administer the affairs of the north-west territories, not yet settled or organized into provinces; and thus the whole of British North America has been organized into a united political confederacy under the name of the Dominion of Canada.

Previous to the confederation of the provinces, Labrador E. of a line drawn due N. of Anse au Sablon, was independent of Lower Canada, and it still remains politically attached to Newfoundland. The tract of country known as Canada till 1867 extended from Labrador westward to the high land beyond Lake Superior, and from the St Lawrence Valley and the great lakes northward to the watershed between them and the Hudson Bay, and embraced an area of 331,220 square miles, lying between the parallels of 41° 71′ and 50° N. lat., and the meridians of 57° 50′ and 117° W. long. This extensive region, which constituted the most important colony of England, is now included in a Dominion which stretches across the North American continent from the Atlantic to the Pacific Ocean, and embraces an area of about 3,500,000 square miles. The vast prairie lands of the great north-west, thus embraced within the Dominion, and out of which the province of Manitoba has been already formed, include the most fertile region of the whole continent. Already immigration is setting steadily in that direction; nor can it be doubted that what has remained till recently a desert, traversed annually by migratory herds of buffalo, and only available as a hunting ground for wild Indians and the trappers of the Hudson's Bay Company, is destined to become the seat of populous provinces, and to constitute one of the chief granaries of the world.

By the addition of the maritime British provinces, included originally within the Acadie of the old French régime, Canada has acquired an extensive line of sea-coast, indented with bays and harbours, offering the most admirable facilities for every branch of maritime enterprise; and to these will, no doubt, be added ere long the island of Newfoundland, with the command of fisheries unequalled in value either in the Old World or the New. The peninsula of Nova Scotia and the island of Newfoundland form the eastern barriers of British North America, closing the Gulf of St Lawrence, and commanding the Atlantic coast, with its ocean trade and its inexhaustible fisheries; while Vancouver Island, and the shores of the neighbouring mainland, stretch along the Pacific coast, with estuaries, inlets, and well-sheltered harbours, awaiting the development of the growing trade of the Pacific. There the rivers abound in salmon; the whale fisheries of the neighbouring ocean already yield valuable returns; and the cod, haddock, and other deep-sea fish invite the enterprise of the young province, and guarantee an inexhaustible source of future wealth.

The people by whom the maritime advantages of the eastern provinces have thus far been enjoyed are peculiarly fitted by origin and training to turn them to the best account. In the early years of the 16th century, when France was striving to outrival Spain in the occupation of the New World beyond the Atlantic, hardy adventurers of Basque, Breton, and Norman blood sailed from Dieppe, St Malo, Rochelle, and other French seaports, and divided among them the traffic in fish and furs of the Newfoundland banks and the Gulf and the River St Lawrence. The discovery of Canada, and, indeed, of the American continent, is justly assigned to John and Sebastian Cabot, who set out from Bristol under the auspices of Henry VII. of England in 1497, and landed on the coast of Labrador seventeen months before Columbus reached the American mainland. But England was slow to avail herself of the advantages of the discovery. In 1524 Verazzano, a Florentine navigator, sailing under the French flag, coasted the new found continent from Florida to Cape Breton, and the whole vaguely defined region was appropriated in the name of Francis I. as "La Nouvelle France." Ten years later Jacques Cartier sailed from St Malo, explored the coasts of Newfoundland, Nova Scotia, and New Brunswick; and for a time the Norman and Breton adventurers enjoyed a monopoly of fish, peltries, and whatever else could reward those pioneers of civilization for their adventurous daring and enterprise.

By such hardy adventurers the maritime provinces were originally settled, before Britain awoke to the importance of the fisheries and other valuable resources of the New World. But she in her turn contributed an energetic body of colonists, including many of Scottish origin; and the war of independence led to a considerable influx of loyalist immigrants from the revolted colonies. War, both then and in 1812, had its usual effect in depressing native industry. But with the return of peace the British provinces entered on a prolonged course of prosperity, very partially affected by the political troubles of 1836–7, or even by the American civil war of 1862 and subsequent years. Half a century ago the population of the whole of British North America was less than 1,000,000; in 1872 that of the four provinces of Ontario, Quebec, New Brunswick, and Nova Scotia, amounted to 3,485,761; and the population of the Dominion now exceeds 4,000,000 of souls.

So long as Canada was detached in government and all political relations from the maritime provinces, and embraced only Quebec and Ontario, with access to the ocean solely by the St Lawrence, which is closed for fully five months in the year, it constituted an inland province, subject to many restrictions, and was to a considerable extent dependent on reciprocal relations with the United States for its foreign trade.

In a "Memorandum on the Commercial Relations, Past and Present, of the British North American Provinces with the United States," submitted to the Government at Washington in April 1874, by Sir Edward Thornton and the Hon. George Brown, as joint plenipotentiaries of Her Britannic Majesty, it is shown that, in the interval from 1845, when a more liberal policy gave encouragement to intimate commercial relations between Canada and the United States, till 1853, the aggregate export and import trade between the two countries rose from $8,074,291 to $20,691,360; and at the same time a large amount of the import and export traffic between Great Britain and the provinces was carried in bond over the canals and railways of the United States. The Reciprocity Treaty was negotiated by the late Earl of Elgin, as governor-general of Canada, and signed on the 5th of June 1854, and it was abrogated in 1866. In the later years of its continuance the civil war in the United States gave a great advantage to Canada, so that in the last year of the treaty the exports to the States amounted to $54,714,383. Yet even then the balance of trade continued to be in favour of the United States; and under the operation of the treaty, New York, Portland, Boston, and other American seaports, were so largely used for the trade of the British provinces, that the transportation traffic sent to and brought from foreign countries, in bond, over the railways and canals of the United States, and in the ocean ships and steamers, of the United States became an important element of revenue to their chief lines of transport.

The effect of all this, at a time when jealousies and heart-burnings had arisen out of the American civil war, led American statesmen to over-estimate the value of such facilities to the British Provinces, and even to conceive that the abrogation of the Reciprocity Treaty, and the restriction of such facilities, would suffice to create a desire for annexation. Happily, experience has led to very different results. In the "Memorandum on Commercial Relations," already referred to, it is remarked :—

"The industry of Canada had been largely directed to the supply of the American market with commodities for home consumption, as well as for foreign exportation, and the repeal in 1866 of the Reciprocity Treaty, under which so vast a trade had grown up, rendered imperatively necessary prompt measures to open new markets for the sale of Canadian produce. These measures were at once taken. Under the influence of the formal notice given by the United States in 1865, of their intention to terminate the treaty, federation of the provinces, then under discussion, was hurried on, and became a *fait accompli* within fifteen months after its repeal. The Intercolonial Railway was at once undertaken, at a cost of over $20,000,000, at the national expense, to secure direct connection to and from the Atlantic ocean, at Halifax and St John, on Canadian soil. Commissioners were despatched to the British and other West India Islands, and to South American States, to promote the extension of direct trade between them and the Dominion. The enlargement of the canals, the improvement of the navigation of the lakes and river St Lawrence, the construction of the Bay Verte canal, to connect the waters of the Bay of Fundy and the St Lawrence, the subsidizing of ocean and river steamship lines, and the promotion of the great shipbuilding and fishery interests, all received a new and vigorous impetus.

"These measures were attended with remarkable success. Only seven fiscal years have passed since the repeal of the treaty, but already the loss inflicted by it has been more than made up, and excellent outlets in new directions opened for Canadian commerce; with an increasing annual proportion of the vast carrying trade formerly done for the provinces by the railways, canals, and steamships of the Republic transferred to Canadian hands. The traffic between the United States and the Provinces at once fell, from an average during the three years before the repeal (according to American official statistics) of nearly $75,000,000 per annum, to an average of $57,000,000 per annum during the first three years following repeal;—the Act of Confederation, too, removed from the category of foreign commerce to that of home consumption the large interchanges of commodities between the several sections of the Dominion; and the aggregate foreign commerce of the provinces consequently fell in the first year after the repeal of the treaty to $139,202,615 from $160,409,455 in the previous year. As will be seen from the following statement, however, the trade of the Dominion speedily recovered from the blow, and the volume of its foreign commerce gradually increased until, in the seventh year from the repeal of the treaty, it reached the great sum (for a people of four millions) of $235,301,203,—being seventy-five millions higher than it had ever reached in any year of the treaty's existence:—

1867.	Total exports and imports of Canada and Newfoundland	$139,202,615
1868.	" "	139,595,615
1869.	" "	142,240,897
1870.	" "	161,275,538
1871.	" "	184,852,006
1872.	" "	205,339,943
1873.	" "	235,301,203
	Total Foreign Commerce in seven years...	$1,207,807,817"

Thus the immediate effect of the repeal of the Reciprocity Treaty was to draw the British provinces into closer union; while, as appears from official returns, the interchange of traffic, which from 1820 to 1866 had been largely in favour of the States, underwent so great a change from 1866 to 1873 as to show a balance against the United States, and in favour of Canada, in value $51,875,008. Wheat, flour, provisions, and other articles, which were formerly sold to New York and Boston houses, are now sent through Canadian channels, direct to the maritime provinces, to Newfoundland, the West Indies, South America, and to Great Britain; and Canada thus enters into competition with the United States in its own foreign markets. Mr E. H. Derby, special commissioner of the United States Treasury, makes this admission as to the effect of the treaty on a single port:—"The commerce of Boston affected by the Reciprocity Treaty exceeds $27,000,000 annually, namely,—imports from and exports to the maritime provinces, $6,000,000; outfits and returns in deep-sea fisheries, $11,000,000; imports of wool, grain, and animals across the frontier of Canada and entered there, with returns, at least $10,000,000." With the union of the maritime provinces to those on the St Lawrence, Canada has passed from the condition of an inland colony, dependent on the good will or the interested aims of a foreign rival, to the position of the fifth maritime nation of the world. The fisheries more than all else have laid the foundation of the industrial progress of the eastern provinces; and in the men who now sail their fishing fleets Canada has acquired the elements of a powerful marine, which, in any national exigency, will be found to add no less to the defensive strength of the Dominion, than it now does to its commercial enterprise.

By right of seniority the province of Quebec claims the first place among the sister provinces of the Dominion, though Nova Scotia may dispute with her the claim of earliest settlement. Among the cities of the Dominion it is probable also that Montreal will retain the pre-eminence by reason of the unparalleled advantages of her geographical position for commercial purposes. In numbers, wealth, and productive industry, however, the foremost rank is at present due to the province of Ontario. Referring to separate articles for a detailed description of each province, we confine ourselves here to what concerns the Dominion as a whole.

Extent.—The Dominion of Canada extends from 45° N. lat. northward to the Hudson Bay, and reaches from the Atlantic to the Pacific Ocean. In superficial extent it is nearly equal to the whole of Europe, and comprises an area of about 3,500,000 square miles. The larger moiety of this, including the territory formerly held by the Hudson's Bay Company, is the property of the Dominion Government. Of this about 120,000 square miles consist of prairie lands with occasional scattered groves and belts of trees along the rivers, admirably adapted for agriculture. A larger tract, consisting chiefly of timbered land, but interspersed with prairies, and well fitted for settlement and farming operations, may be estimated to cover little short of 500,000 square miles. Beyond those two available regions of land, adapted, by soil and climate, for the growth of wheat and other grains, and the rearing of stock, there is a further belt of land, which, though lying in a colder zone, is timbered, clothed with good natural grasses, and as fit for the growth of barley and oats as are many of the less genial regions of Northern Europe which support a considerable agricultural population. This northern belt of timbered land is estimated at little less than 930,000 square miles. All this, as well as much more still uncleared within the various provinces, has to be settled and brought under cultivation; and out of the great prairie and forest lands of the north-west have yet to be fashioned the future provinces of the Dominion of Canada.

Population.—The population of the whole Dominion in 1871, exclusive of Indians beyond the limits of the provinces, was 3,485,761, but to this has since been added the provinces of British Columbia, Manitoba, and Prince Edward Island: thereby increasing the population to nearly 4,000,000. To this a large addition has since been made, both by natural increase and by immigration. The entire population of Canada in 1875 was estimated to amount to 4,000,000, exclusive of Indians, estimated at [illegible].

Indians.—In the older provinces of Canada the Indians have long since been gathered together into settlements, under the care of superintendents and other officers of the Indian department, and in some cases, with industrial schools and other organizations for accelerating their pro-

gress to an equality in all respects with the white settlers. Missions under the care of different Christian churches have also undertaken the work of religious training, and the supervision of their schools. Of the bands of Indians thus settled on their own reserves, accurate statistics are furnished in the annual reports of the Indian Department. But only a vague estimate can be formed of the actual numbers even of the Crees, Blackfeet, Sioux, and other wild tribes which wander in the vicinity of the Red River settlements, or are brought into trading relations with the factors of the Hudson's Bay Company. The following estimate of the Indian tribes throughout the Dominion of Canada is based on the most recent information; and probably forms a fair approximation to their actual numbers:—

Ontario	14,184
Quebec	10,843
Nova Scotia	1,765
New Brunswick	1,386
Prince Edward Island	323
Manitoba and N.W. Territories	23,800
British Columbia	28,500
Rupert's Land	4,500
	85,301

Nationalities.—The nationalities of the population of Canada are in some respects peculiar. The first settlement made by Europeans, as has been already noted, was by the French navigator Jacques Quartier, or as he is now universally styled, Cartier, in 1535. He explored the coasts of Newfoundland, previously discovered by Cabot, and those of Nova Scotia and part of the Gulf of St Lawrence, and took possession of them in the name of Francis I. For two centuries and a quarter thereafter Acadie and Canada were provinces of France; and when, in 1759, they passed to English rule, a French population of 65,000 souls changed their allegiance. Everything was then done, consistent with British honour, to make the change as easy as possible. They were secured in the undisturbed possession of their lands, and in the free exercise of their religion. All ecclesiastical property was respected; and the rights of the church so effectually guarded, that the only remnant of a state church in the Dominion is the Roman Catholic church in the province of Quebec, with its great wealth, its control of education, and its right to levy tithes and other church dues from its adherents. The French laws in like manner remained intact; except in so far as the new subjects of England welcomed the substitution of its criminal law, and trial by jury, for the arbitrary rule of intendants and other representatives of an absolute monarchy. By such means the language and customs of the French population of Canada have been perpetuated, and continue to exercise a marked influence on the character of the country as a whole; though the results of confederation are already tending to diminish this, and to limit the French element to the old province of Quebec. The Canadian population of French descent now numbers 1,082,940; and in the fresh stimulus given in recent years to immigration, strong inducements have been held out to the expatriated inhabitants of the former French provinces of Alsace and Lorraine, to seek a home among the French Canadians of Quebec.

The other nationalities of the Dominion include in the returns of the last census 64,447 natives of the United States in the four provinces of Ontario, Quebec, New Brunswick, and Nova Scotia, who may be assumed to comprise immigrants of English, Scottish, and Irish descent, with an undetermined foreign element. Besides those the Irish population of Canada now amounts to about 850,000, the English to upwards of 700,000, the Scotch to 550,000, the Germans and Dutch to upwards of 230,000, the mixed race of African descent to nearly 22,000; the Welsh to 7800; Swiss, 2962; Norwegians, Swedes, Danes, and Icelanders, 7000; Italians upwards of 1000; and Spaniards, 900. The abrupt emigration of the Icelanders from their remote Arctic home, consequent on recent volcanic disturbances, along with other causes, has led a number of them to seek a home in Canada. The Mennonites, a Russian sect holding opinions closely allied to the Quakers in reference to bearing arms, have left their homes in large bands, and many of them are settling in Manitoba, and other parts of Canada. Added to all those, have to be taken into account the miscellaneous elements of the new population of British Columbia,—Greek, Mexican, Spanish, French, German, Chinese, and Japanese; in addition to which the native Indian population constitutes an important element. The mixture of Indian and White blood has been considerable in the older provinces, and cannot fail to affect largely the population of Manitoba and the North West. Nevertheless in Canada, as in the United States, British race and British institutions alike predominate, and give a tone and character to the people, the influence of which increases after a few generations, as the foreign element is gradually absorbed into the prevailing stock.

The peculiar geographical position of Canada, in immediate proximity to the United States, places it in very different circumstances from Australia, New Zealand, and other British colonies, in reference to immigration. With thousands annually sailing to New York and other United States ports, yet destined for Canada, and many more selecting the route by Liverpool and Quebec to the Western States, it is only by the definite returns of the decennial census that the actual results of immigration can be determined. The following tabular statements compiled from the official reports of the Minister of Agriculture for the Dominion, to whose department the charge of immigration is assigned, and from the returns of emigrant agents, and other sources, will suffice to convey some accurate idea of the rapid increase of the population from this source. The first table shows, in column I., the total number of emigrants from Europe who landed in the St Lawrence during a period of eight consecutive years, from 1866 to 1873. Column II. shows the number of immigrants entering Canada at all points, in so far as they came under the cognizance of immigrant agents, or other Government officials, who were reported to have settled in the Dominion. Column III. shows the numbers who gave a preference to the route by the St Lawrence, and, arriving at Canadian ports, proceeded from thence direct to the United States. The increase in the number of immigrant settlers in Canada within the above period, it will be seen has been five-fold. In reference to the third column there is a compensating element in the fact that, not only many of the better class of emigrants who seek a home in Canada choose the route by New York, and so enter the provinces overland, but the Minister of Agriculture draws special attention to a feature in the returns, showing a direct emigration from the United States to Canada. This is liable to be affected largely by the conditions of trade and industrial progress in either country. In 1873 the number of immigrants from the United States to Canada amounted to 8971 persons.

Year.	I.	II.	III.
1866	28,648	10,091	41,704
1867	30,757	14,666	47,212
1868	34,300	12,765	58,683
1869	43,114	18,630	57,202
1870	44,475	24,706	44,313
1871	37,020	27,773	37,949
1872	34,743	36,578	52,608
1873	36,901	50,050	49,059
Total	289,958	195,259	388,720

The character of the above Canadian immigration as an addition to the industrial population of the Dominion may be partially tested by the following classification of the occupations or trades of the heads of families and other adult males who landed at Quebec during the last-named four years.

Occupations.	1870.	1871.	1872.	1873.
Farmers	4,144	2,989	2,336	1,470
Labourers	12,248	11,465	6,189	6,202
Mechanics	1,717	1,674	6,809	7,662
Clerks and Traders	146	89	79	62
Professional Men	10	4	14	7
Total	18,265	16,221	15,427	15,403

In the year 1872 the total number of emigrants who sailed from British ports, both to the Colonies and to foreign states, amounted to 295,213; but 26 per cent. of the whole were foreigners, availing themselves of the route through Great Britain to their final destinations.

Climate.—The variations of the Canadian climate are less than in many countries of much smaller extent. But throughout nearly its whole area, Canada is characterized by greater heat in summer and a much lower temperature in winter than in corresponding European latitudes. Its general character is level, though it includes the Rocky Mountains, with the picturesque and diversified region lying between them and the Pacific, and the Laurentian range, continued northward to the Arctic Ocean.

Besides the great lakes which find their outlet through the St Lawrence to the sea, there are thousands of lakes throughout Canada, many of them of large dimensions. Foremost among those is Lake Winnipeg. The two great branches of the Saskatchewan take their rise in the Rocky Mountains, and after uniting their streams, flow into this lake, which also receives the Assiniboin, the Red River, and other smaller rivers. The St Lawrence and the great lakes, of which it is the outlet, are estimated to contain 12,000 cubic miles of water; and the Niagara Falls, which constitute the main feature in the descent from Lake Erie to Lake Ontario, are on a scale commensurate with this vast fresh water system of rivers and lakes. The River Niagara issues from Lake Erie in a broad, tranquil stream, varying in breadth from one to three miles, and continuing through a course of about 15 miles, with a fall of little more than a foot per mile. But on reaching the rapids, the descent is suddenly increased to about 80 feet in less than a mile, before the waters reach the grand leap of about 165 feet perpendicular over the great falls. The Horse-Shoe Fall, on the Canadian side is upwards of a third of a mile broad. Between this and the American Fall Goat Island intervenes; and then another volume of water, about 600 feet wide, plunges with like abruptness into the abyss below. The great breadth as compared with the height of the falls tends in some degree to mislead the eye in the first impression produced; and it is only by slow degrees that the mind is brought to an adequate estimate of the grandeur of the scene. Sir Charles Lyell thus describes the effect produced on his mind, at a first glance, and after prolonged study of all their remarkable features:—"We first came in sight of the Falls of Niagara when they were about three miles distant. The sun was shining full upon them—no building in view—nothing but the green wood, the falling waters, and the white foam. At that moment they appeared to me more beautiful than I expected, and less grand; but after several days, when I had enjoyed a nearer view of the two cataracts, had listened to their thundering sound, and gazed on them for hours from above and below, and had watched the river foaming over the rapids, then plunging headlong into the dark pool, and when I had explored the delightful island which divides the falls, where the solitude of the ancient forest is still unbroken, I at last learned by degrees to comprehend the wonders of the scene, and to feel its full magnificence." The river passes over the centre of the Horse-Shoe Fall in a solid column of water of 20 feet; and it is estimated that fifteen hundred millions of cubic feet pass over the falls every minute. This great water system of rivers and lakes affects the climate of the older provinces of Canada; and the other large rivers, with the numerous bodies of fresh water distributed over so large a portion of the whole surface of the Dominion, help to preserve an equable climate, and afford many facilities for local transport.

Reckoning Lake Erie and Lake Ontario with the Niagara River as parts of the St Lawrence, the river system trends in a N.E. direction throughout the whole course from Point Pelee, which is situated in 42° lat., to Tadousac, the earliest French trading port, at the mouth of the Saguenay, in 48° 2' lat. From this the coast still continues to trend northward till it merges in the inhospitable shores of Labrador, in a latitude which is still as far south as London at the Strait of Belle Isle. The degrees of latitude indeed, are a very partial guide to the character of the Canadian climate as compared with that of the British Isles; and any statement of the mean temperatures of the two is deceptive. The severity of the winter, as tested by the thermometer, leads to a very exaggerated impression of Canadian experiences. Owing to the dry, clear, bracing atmosphere which generally prevails, the sense of discomfort produced by the raw easterly winds and damp fogs of an English spring suggests an idea of cold, such as is rarely thought of in a Canadian winter. There are indeed, every winter, a few days of intense cold, as in the summer there are brief periods of equally intense heat, when the thermometer ascends, or descends, through a scale unknown in the more equable English climate. But throughout the greater part of the winter season in Canada the sky is bright and clear, and the weather thoroughly enjoyable. Open sleighs are in use by all. Sleighing parties of pleasure are arranged for the period of full moon, that they may return home over the snow, after an evening's enjoyment at some appointed rendezvous; skating, snow-shoeing, and other outdoor exercises are in universal favour; and the sound of the sleigh-bells in the open thoroughfares adds to the exhilarating sense produced by the pure bracing atmosphere. Snow accordingly brings with it no such ideas of discomfort as are associated with it in England; while by the farmer it is hailed as altogether beneficial. In the province of Quebec the snow begins to lie early in November; in Ontario it is fully a month later; and it differs correspondingly at various localities throughout the Dominion. But everywhere the appearance of the snow is hailed as seasonable and beneficial. It protects the wheat sown in autumn from the frost, affords facilities to the farmer for bringing his produce to market, aids the lumberer in collecting the fruits of his labour in the forest at suitable points for transport by water with the spring freshets, and so contributes alike to business and pleasure.

The following tables, carefully prepared from official reports transmitted to Professor Kingston, director of the Magnetic Observatory, Toronto, from the chief stations throughout the Dominion, supply reliable data for determining the temperature and climatic changes at the most important points throughout Canada and Newfoundland. In the column of first frost at Montreal, as shown in the last of the tables, the dates for the years 1872, 1873, and 1874 indicate the first fall of the thermometer to 32°, while the earlier dates mark the first hoar frost of the autumn.

Mean Temperature (in degrees Fahr.) for each Month and for the Year in the several Provinces, and for certain Stations in the Dominion of Canada.

	Jan.	Feb.	March.	April	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Ontario	19·3	20·2	26·7	42·6	54·4	65·6	69·8	68·1	58·6	47·4	33·0	20·5	43·8
Quebec	13·5	15·9	25·3	41·8	54·9	66·0	70·2	68·1	58·7	47·0	33·1	17·1	42·6
New Brunswick	16·1	18·1	26·4	37·6	46·4	57·7	62·8	61·4	54·2	45·1	32·3	19·8	39·9
Nova Scotia	22·3	21·2	26·7	35·9	44·6	56·6	63·3	62·9	56·4	48·2	36·5	25·5	41·7
Prince Edward Island	20·5	14·7	27·6	33·1	46·2	54·0	64·3	62·7	57·2	49·4	32·7	22·9	40·5
Manitoba	2·9	3·0	9·0	30·2	51·2	63·6	65·9	64·8	51·3	40·0	14·6	0·6	32·6
British Columbia	22·8	28·8	40·8	51·9	59·9	64·5	72·2	70·7	61·4	49·3	30·0	24·5	48·1
Newfoundland	25·6	22·7	28·7	33·3	43·0	50·7	60·3	60·1	55·8	49·6	38·0	28·9	41·4
Toronto	22·9	22·9	29·3	41·0	51·7	61·7	67·4	66·2	58·1	45·9	36·2	25·7	44·1
Montreal	16·8	18·6	26·9	43·5	57·2	66·4	72·2	69·8	60·8	47·5	33·6	18·9	44·3
St John, New Brunswick	18·4	21·4	27·8	38·2	46·7	54·7	59·7	59·5	54·5	45·6	35·7	22·8	40·5
Halifax	22·9	23·7	28·1	38·1	47·4	59·7	63·5	63·3	57·4	48·3	37·8	25·8	43·1

Averages of the Highest Temperatures in each Month and Year for various places in the Dominion of Canada from three or more years.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
ONTARIO.													
Toronto	43·9	44·4	51·9	67·2	76·2	86·1	89·2	86·0	81·2	68·6	56·9	47·3	91·1
Goderich	45·1	46·2	52·8	72·8	78·5	86·6	87·0	86·2	81·2	72·3	57·2	44·6	89·1
Windsor	48·9	53·5	58·5	78·6	83·6	92·0	93·6	92·6	89·1	78·6	61·8	48·4	95·1
Woodstock	47·3	51·2	52·0	77·5	85·5	89·6	89·6	90·9	85·6	73·1	50·9	41·2	92·8
Barrie	46·7	47·8	55·7	73·6	81·3	87·1	91·6	88·5	89·2	78·4	63·6	45·4	93·5
Peterborough	43·3	45·8	50·5	72·3	83·2	90·5	92·2	91·3	86·8	73·6	56·8	43·9	94·2
Pembroke	40·9	44·9	55·8	68·9	87·4	93·9	93·8	88·7	84·2	75·4	57·3	40·7	95·1
QUEBEC.													
Montreal	40·7	43·3	52·8	73·8	87·1	89·9	92·3	90·1	84·1	79·9	58·8	44·6	96·1
Quebec	38·2	37·6	43·7	61·4	81·9	90·2	89·6	82·5	78·9	69·2	46·4	38·8	90·6
NEW BRUNSWICK.													
St John	40·8	41·0	45·8	56·8	67·2	75·4	78·6	76·2	70·6	60·6	54·2	44·6	79·0
Bass River	42·0	39·9	48·0	56·1	77·8	88·0	87·1	85·1	78·5	69·4	56·9	41·3	88·6
NOVA SCOTIA.													
Halifax	47·4	45·7	52·1	63·6	78·9	83·2	86·1	86·4	81·0	72·4	59·1	48·3	88·3
Glace Bay, C. B.	48·2	42·2	47·2	57·0	70·4	80·0	85·9	82·9	76·2	69·4	55·8	48·2	86·7
Sydney	48·7	43·3	49·2	57·2	75·4	79·5	83·4	84·0	75·0	69·2	56·9	48·1	85·6
PRINCE EDWARD ISLAND.													
Charlottetown	48·8	41·8	49·1	52·6	74·7	78·8	87·0	82·3	73·8	68·6	55·0	45·0	87·0
MANITOBA.													
Winnipeg	27·5	36·6	38·6	64·3	82·8	91·6	95·2	92·3	84·8	72·4	43·4	30·0	96·1
BRITISH COLUMBIA.													
Spence's Bridge, Thompson River	47·7	51·3	67·7	80·7	87·4	87·7	96·7	93·7	87·3	77·7	57·7	45·3	96·7

Averages of the Lowest Temperature in each Month and Year for various places in the Dominion of Canada from three or more years.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
ONTARIO.													
Toronto	– 7·1	– 7·4	2·4	19·2	30·6	38·3	46·4	44·4	34·3	24·9	14·8	– 2·7	–12·1
Goderich	– 1·3	– 1·1	2·1	21·6	28·4	39·1	46·4	44·5	36·3	28·8	13·9	– 2·9	– 8·8
Windsor	– 5·6	– 7·9	1·5	23·0	33·4	44·9	48·8	48·3	35·4	25·7	11·9	– 7·4	–14·9
Woodstock	– 7·6	–13·0	5·2	22·2	28·5	36·0	42·2	44·1	29·6	20·2	1·1	–15·5	–18·2
Barrie	–17·4	–18·7	– 6·1	18·0	27·0	37·6	46·6	42·1	34·1	25·3	10·8	–19·9	–26·5
Peterborough	–20·7	–15·5	–11·1	16·3	27·1	36·7	43·2	36·7	28·2	16·3	1·0	–22·8	–25·9
Pembroke	–32·7	–26·5	–23·2	11·0	26·8	36·1	44·4	37·8	30·0	20·3	0·0	–26·8	–37·3
QUEBEC.													
Montreal	–18·2	–12·2	– 9·5	27·4	37·2	49·7	53·4	52·0	41·2	28·9	– 3·5	–12·3	–17·2
Quebec	–20·3	–17·8	– 8·9	17·5	30·9	42·2	46·6	45·5	36·4	25·6	3·4	–16·8	–23·5
NEW BRUNSWICK.													
St John	–11·0	– 6·4	– 1·2	20·2	31·8	43·0	49·0	48·4	41·0	25·0	12·8	– 5·8	–10·6
Bass River	–20·2	–15·2	– 3·4	17·4	25·4	40·0	47·8	41·6	33·7	20·0	7·0	–12·5	–22·6
NOVA SCOTIA.													
Halifax	– 6·2	– 3·0	– 0·7	19·8	25·8	37·6	50·2	44·3	36·5	25·7	16·7	1·9	– 8·3
Glace Bay	– 3·6	– 4·7	0·1	16·5	24·8	33·6	40·2	44·2	37·0	25·8	19·6	6·2	– 7·5
Sydney	– 6·3	– 5·3	– 4·3	14·7	25·0	32·3	38·3	41·4	33·6	24·7	19·7	– 5·1	– 9·8
PRINCE EDWARD ISLAND.													
Charlottetown	–15·0	–15·7	– 2·0	14·7	27·7	36·6	44·9	45·1	39.4	32·2	18·7	– 8·7	–16·5
MANITOBA.													
Winnipeg	–35·9	–33·2	–29·3	1·0	25·4	38·1	41·2	40·4	26·1	8·1	–28·8	–34·2	–38·6
BRITISH COLUMBIA.													
Spence's Bridge	– 7·7	– 5·3	16·5	31·7	39·4	47·0	53·0	49·7	36·3	27·0	2·3	2·7	–16·7

Monthly and Annual Rainfall in Inches for various places in the Dominion of Canada from three or more Years.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Toronto	1·23	0·89	1·62	2·44	3·25	2·98	3·25	3·02	3·72	2·39	2·98	1·65	29·42
Goderich	0·66	0·55	1·39	1·81	3·38	2·39	2·94	2·78	3·28	2·46	1·44	0·84	23·92
Windsor	1·19	1·14	1·56	1·87	3·63	3·15	2·41	2·14	1·69	1·76	2·42	0·82	23·78
Woodstock	0·59	0·58	1·31	1·60	3·04	2·45	2·96	4·41	2·93	2·64	0·95	0·82	24·28
Barrie	0·01	0·18	1·12	1·66	2·84	2·37	3·01	2·28	2·84	2·35	1·42	0·63	20·71
Peterborough	0·64	0·36	1·01	1·89	1·96	2·03	2·45	2·60	3·22	2·93	1·81	0·65	20·55
Pembroke	0·15	0·15	0·56	1·33	3·06	2·28	2·51	2·36	3·21	2·58	1·09	0·21	19·49
Montreal	0·64	0·42	1·41	1·30	2·26	3·01	2·26	3·62	3·9	3·75	2·66	0·85	27·26
Quebec	0·25	0·00	0·42	1·17	2·52	1·11	2·52	4·27	2·81	2·89	0·95	0·00	19·26
St John	2·13	2·86	2·23	3·14	4·51	3·00	3·45	3·89	4·38	4·68	5·33	2·67	33·27
Bass River	1·30	0·61	0·92	2·13	2·83	3·30	2·53	3·77	2·58	4·83	3·78	1·15	29·78
Halifax	3·66	3·39	2·91	3·10	4·17	3·04	2·37	3·61	3·69	5·02	4·68	3·44	43·08
Glace Bay, C. B.	4·29	4·35	3·96	4·22	3·49	4·50	3·95	4·27	5·37	6·44	5·69	4·96	55·49
Sydney	3·49	3·16	2·20	4·03	3·46	3·16	3·42	5·07	5·48	5·04	6·58	4·03	49·42
Charlottetown	2·27	0·68	1·12	0·97	2·44	3·79	2·92	3·48	3·94	4·62	2·46	1·06	29·75
Winnipeg	0·00	0·00	0·33	0·80	2·72	3·84	2·75	2·12	3·73	0·54	0·00	0·00	16·83
Spence's Bridge	0·08	0·19	0·00	0·21	0·78	0·81	0·25	0·47	0·32	0·20	0·37	0·20	3·88

Average Fall of Snow in the several Provinces of the Dominion of Canada, with the number of Days' Snow, and number of Days' Rain.

	Depth of Snow in Inches.									Total Snow in Season.	No. of Days' Snow.	No. of Days' Rain.
	September.	October.	November.	December.	January.	February.	March.	April.	May.			
Ontario	...	2·2	13·5	20·1	25·1	14·9	19·9	2·2	S	95·9	58	89
Quebec	...	2·0	13·9	23·2	31·8	16·4	17·5	8·8	1·4	115·0	60	94
New Brunswick	...	1·3	10·1	31·9	19·2	19·6	15·3	10·2	0·8	108·4	58	107
Nova Scotia	...	0·8	4·0	21·9	17·6	18·9	11·8	13·3	1·1	92·4	52	117
Prince Edward Island	...	...	12·5	26·9	15·6	22·1	17·6	17·2	0·5	112·4	78	129
Manitoba	3·1	4·8	11·6	8·9	7·4	13·4	9·7	3·6	0·0	62·5	59	62
British Columbia	...	...	6·0	8·7	10·0	5·5	3·3	S	0·0	33·5	27	66

Dates of Certain Periodic Events at Toronto and Montreal.

Year.	Toronto				Montreal.			
	First Snow.	First Frost.	Last Snow.	Ice left Bay.	First Snow.	First Frost.	Last Snow.	Ice left River.
1849	October 20	September	April 27	March 29	November 27	October 5	April 13	April 7
1850	November 10	,,	,, 20	April 3	,, 17	,, 14	,, 14	,, 9
1851	October 25	,,	May 8	March 24	October 25	,, 2	,, 6	,, 9
1852	November 11	,, 13	,, 20	April 17	,, 17	September 17	,, 16	,, 19
1853	October 25	,, 12	,, 10	March 31	,, 24	,, 12	,, 14	,, 24
1854	,, 16	,, 19	April 29	April 8	,, 15	,, 11	,, 30	,, 25
1855	,, 12	,, 28	May 8	,, 16	,, 24	August 9	,, 11	,, 28
1856	,, 30	,, 22	,, 30	,, 19	November 1	,, 26	May 31	,, 24
1857	,, 28	,, 21	,, 10	March 30	October 20	September 7	April 27	,, 18
1858	,, 8	,, 18	April 25	,, 27	November 4	August 25	,, 22	,, 9
1859	,, 19	,, 6	June 4	June 27	October 20	October 7	,, 23	,, 4
1860	September 25	,, 21	April 25	March 15	September 29	September 3	May 20	,, 10
1861	October 24	,, 22	May 6	,, 29	October 23	,, 5	April 17	,, 24
1862	,, 25	August 30	April 23	Feb. 28	November 10	August 24	May 7	,, 23
1863	November 8	,, 26	May 5	,, 14	,, 11	October 24	,, 2	,, 25
1864	October 8	September 17	April 13	March 2	October 8	September 26	April 18	,, 13
1865	,, 26	,, 12	,, 23	April 1	,, 28	October 21	,, 20	,, 10
1866	,, 31	,, 15	,, 26	,, 2	,, 4	September 16	May 3	,, 19
1867	November 4	,, 11	May 2	March 27	November 5	,, 23	,, 2	,, 22
1868	October 16	,, 17	April 23	April 1	October 17	October 24	April 23	,, 17
1869	,, 18	August 31	May 1	,, 1	September 27	September 26	May 3	,, 23
1870	November 10	,, 27	April 5	,, 1	October 29	,, 6	April 5	,, 18
1871	October 17	September 18	,, 12	March 13	,, 16	,, 8	March 27	,, 8
1872	,, 15	,, 3	,, 23	April 9	,, 11	October 12	April 24	
1873	,, 20	,, 15	,, 25	,, 2	,, 29	,, 29	May 14	
1874	,, 13	,, 30	,, 26	,, 18	,, 31	,, 13	,, 2	

As will be seen from the previous tables, January and February are the coldest months of the year. Throughout the whole of Canada steady sleighing is reckoned upon during those months. In Quebec and in Manitoba a longer period of sleighing can be relied upon. In Nova Scotia, New Brunswick, and Prince Edward Island, and also on the Pacific coasts, the temperature is modified both in summer and winter according to vicinity to the sea. Abrupt changes of temperature occur both in summer and in winter. A period of great cold early in the month of January is so frequently followed by a complete change that its periodicity is reckoned upon under the name of the January thaw. Snow finally disappears in Quebec about the middle of April. In Ontario it is generally gone a month earlier. The table of average fall of snow given above shows its prevalence at various central points in each of the provinces of the Dominion, from October to the end of April.

Ploughing usually commences in Ontario about the middle of April and in favourable seasons is prolonged into the month of December. But throughout the Domi-

nion, stretching as it does across the continent, and embracing an area nearly equal in size to Europe, the period varies with the locality, and is affected by the vicinity of the great lakes or other local influences. Cattle are turned out to graze in April, feeding in part upon the tender shoots of the spring forest growth, until the appearance of the young pasture with the disappearance of the snow. Before the end of July harvest begins; and with the rapidity of growth under the warm Canadian skies, the hay, grain, and root-crops follow in swift succession; the cleared land is brought again under the plough, and the autumn sowing of wheat is carried on till another abrupt change brings the season to a close. In this way the Canadian climate is marked by the striking contrast of two seasons—summer and winter,—bringing with them alternations of fruitful labour and of repose intermingled with profitable industry and pleasure. This characteristic prevails with slight variations throughout the greater part of the Dominion. Manitoba presents in this respect no marked diversity from Quebec or Ontario. Spring opens nearly at the same time from Red River to the Athabasca. Early in April the alders and willows of the Saskatchewan country are in bloom; the prairie anemone covers the southern exposures to the very verge of the retreating snow. May there brings with it more of the true summer heat than in the provinces on the St Lawrence. But the nights are cool, and throughout the period of greatest heats, the cool night breezes beget a welcome and refreshing change, accompanied with heavy dews. This protects the cereals from the effects of drought even in the driest seasons, and produces a rich growth of prairie grass, making the climate peculiarly favourable for the stock farmer. The Rev. Professor Bryce, of Winnipeg College, thus writes: "The juncture of the seasons is not very noticeable. Spring glides insensibly into summer, summer into fine autumn weather, which, during the equinox, breaks up in a series of heavy gales of wind accompanied by rain and snow. These are followed by that divine aftermath, the Indian summer, which attains its true glory only in the north-west. The haziness and dreamy fervour of this mysterious season have often been attributed to the prairie fires, which rage over half a continent in the fall, and evoke an enormous amount of heat and smoke." His own observations incline him to accept this explanation. Winter begins with crisp clear weather, which grows increasingly cold and cloudy. The wind wheels to the north-east, and with it comes the snow, and the long steady winter of the Canadian year.

The character of the Manitoba winter is thus described by the same intelligent observer:—"The winters of the north-west, upon the whole, are agreeable, and singularly steady. The moccasin is dry and comfortable throughout, and no thaw, strictly speaking, takes place till spring, no matter how mild the weather may be. The snow, though shallow, wears well, and differs greatly from eastern snow. Its flake is dry and hard, and its gritty consistence resembles white slippery sand more than anything else. Generally speaking, the farther west the shallower the snow, and the rule obtains even into the heart of the Rocky Mountains. In south-western Ontario the winter is milder, no doubt, than at Red River; but the soil of the north-west beats the soil of Ontario out of comparison; and after all, who would care to exchange the crisp, sparkling, exhilarating winter of Manitoba for the rawness of Essex in south Ontario."

But the frosts of spring and autumn, not those of winter, are what the Canadian farmer learns to regard with any dread; and this is still more true in reference to the Canadian fruitgrower. But in this respect the north-west climate is exceptional in its character. Frosts are common there in the nights of September; but the fact has been noted by many independent observers, that frost which would injure grain in many other countries, appears to be innocuous on the Red River and the Saskatchewan. Various reasons have been assigned—such as the dryness of the atmosphere, the heat-retaining character of the soil, and the sudden change of temperature that enables vigorous plants to bear an atmosphere at 20° better than at 35° when the latent heat of the earth and the plants has been given off. But whatever be the true cause the fact appears to be well attested. The chief lesson which experience has taught the farmer is to sow his wheat early in the spring, so that the ear shall be past the milky stage before the frost comes.

The climate and other conditions to the west of the Rocky Mountains are necessarily marked by much greater local variations owing to the broken character of the country, with its ravines and deep narrow valleys. Stock raising has hitherto largely occupied the attention of the farmers on the Pacific slope, where the farms are called "ranches," after the fashion of the stock farmers of California and New Mexico. The ground produces both cereals and vegetables where irrigation is resorted to, as in the plains and valleys of those states. But the rich natural grass which abounds furnishes nearly all that is needed for the profitable raising of stock; and until a large female immigration restores in some adequate degree the natural proportion of the sexes, the rough life of the "ranch," with its "corral," or cattle-pen, will be preferred to the more settled industry of the agriculturist.

The capacity of the different provinces for profitable industry, and the character of their native productions, will be found set forth in detail in the separate articles on each province. It is vain to attempt any detailed account of the soil and other local specialties of half a continent. The Geological Survey, carried out under the able direction of the late Sir W. E. Logan and his successor Mr A. R. C. Selwyn, has largely contributed to an accurate knowledge of the agricultural capabilities, as well as the mineral resources of the country. Vast areas consist chiefly of loam, with a substratum of gravel, overlaid throughout extensive tracts of forest by a rich vegetable mould, the accumulation of ages. The prairie lands are not less available; and they are now being surveyed and explored, alike for the requirements of the settler and for economic and scientific results.

The Reports of the Geological Survey of Canada embody in this way a readily accessible guide to the resources of the country, and the suitability of its various districts and provinces for settlement. Entire districts of many square miles in extent prove to be composed of alluvial deposits from 30 to 40 feet deep, of soil in places so rich as to bear good crops of wheat for successive years without manure. Others of nearly equal value are found resting on red sandstone, trap, serpentine, limestone, and other strata most favourable for agriculture. There are also, as along some of the rivers, for miles in succession, soils too rich for wheat, others of a good sandy loam, suitable to and requiring the usual English rotations. In many parts, on the other hand, there exist considerable tracts of poor, thin, and stony soils. The Reports of the Geological Survey, in presenting an account of the geological distribution of the various strata, and their agricultural capabilities, will prove of great value to the immigrant, as well as to others interested in the lands of Canada.

The soil and climate of Canada are such that the country produces a much greater variety of grains and fruits than is usually grown in Great Britain or Ireland. Besides wheat, barley, oats, rye, pease, turnips, potatoes, hemp, flax, hops, and the other ordinary agricultural products of

England, which are all raised in abundance, Canada grows tobacco, rice, maize or Indian corn, and fruits of warmer climes than the British Islands. The full and steady heat of the summer matures with surprising rapidity the most valuable productions, while the long period of repose of the Canadian winter is not only amply atoned for by the rapid and luxuriant vegetation of the summer, but, no doubt, contributes to such results.

Fruits and Vegetables.—The fruits of Canada embrace all that are familiar to the English gardener, with others which the summer there is not warm enough to bring to maturity. The finest melons are grown in abundance in the open ground. In favourable seasons peaches are plentiful in the Niagara peninsula, and in the south-western portions of Ontario, along the shores of Lake Erie and the Detroit River. The vine is cultivated largely in open gardens. The Isabella, the Delaware, Clinton, and other varieties of grapes attain to perfect size and excellent flavour in the open air; and the manufacture of native wines is now successfully prosecuted to a considerable extent.

Wild fruits abound in great variety throughout many Canadian districts. The wild vine (*Vitis vulpina*) is abundant everywhere, twining its tendrils around the trunks and over the branches of the forest trees, and yielding clusters of small grapes, inviting to cultivation. Among the other wild fruits may be mentioned plums, cherries, raspberries, brambles or blackberries, strawberries, whortleberries, blueberries, gooseberries, black and red currants, juniper berries, cranberries, hickory and hazel nuts, and walnuts. The raspberries ripen in such abundance that enormous quantities are annually preserved and sold both in the Provinces and the United States. The blueberry is also extensively sold; and the wild strawberry furnishes an agreeable dessert in many parts of the eastern provinces throughout the latter part of July and August.

Apples and pears are now largely cultivated. The island of Montreal has long been famous for its fruits; and the annual produce of the orchards of Ontario is exported to the States and to Europe. Vegetables for the table are also successfully cultivated in greater varieties than in England, and in such quantities that they are largely exported. The tomato flourishes and yields an abundant crop. Cauliflower, vegetable marrow, squash, French beans, pease, lettuce, spinach, celery, asparagus, rhubarb, and all the more common vegetables are grown in abundance in the older provinces. The climate of Manitoba, notwithstanding its exceptionally low temperature from December to March, gives promise of equally satisfactory results. Professor Bryce, after noting such examples of agricultural produce as that of one old settler who obtained 420 bushels of wheat from 11 acres, and another who by garden culture produced the enormous yield of 134 bushels per acre of oats, thus proceeds: "These are given both as proof of the capabilities of the country, and of the advantage of careful culture. The ordinary table vegetables are surprising in their growth, and reach a prodigious size. The writer has seen nothing in his previous experience equalling the vegetable production of the province; and the late lieutenant-governor, Hon. Mr Archibald, after testing the matter in his own garden, gave the same as his experience."

The exports of fruit and vegetables, the growth and produce of the five eastern provinces of Canada, for the year 1874, included fruit to the value of $128,904, and vegetables to the value of $332,068. But while this produce of the finer fruits and vegetables for the table shows exports to the value of $460,972 in a single year, and thus bears evidence to the character of the soil and climate, it conveys a very imperfect idea of the actual produce of Canadian orchards. Apples especially are in constant use at the table. Throughout the southern portion of Ontario thousands of acres are planted with fruit-trees, yielding valuable crops of the finest quality, and forming an ever-increasing source of wealth to the farmer.

Flowers.—The flora of Canada naturally comes in order along with its agriculture and garden produce; but to deal with the subject effectually would require a botanical treatise on the whole flora of North America. There is the rich flora of the forest, which disappears with the clearing of the land for purposes of agriculture, and is even replaced in part by an immigrant flora, brought in with the hay and grass seeds of the European settler. Again, there is the brilliant flora of the prairies, which, in the full season of summer bloom, are resplendent with blue, scarlet, and yellow petals. The Rocky Mountains, and the rugged slopes of the Pacific province, have also their characteristic flora; while the shallows of the lakes and rivers abound with beautiful aquatic plants, foremost among which is the *Nymphæa odorata*, the magnificent sweet-scented white water-lily, which converts many a broad lagoon into a beautiful floating garden.

It will better accord with the practical aim of this article, to note that the honey-bee flourishes in all the provinces of Canada; aud, as will be seen by the following table showing the produce of a single year, is cultivated with profitable success in the four older provinces:—

	Hives of Bees.	Pounds of Honey
Nova Scotia.	3,038	21,374
New Brunswick	5,854	90,004
Quebec	41,295	648,310
Ontario	94,604	1,239,612
Total	144,791	1,999,300

Forests.—The forests of Canada abound in fine timber, adapted to almost every variety of useful or ornamental work, and furnishing one main element of wealth to the province. Foremost in point of utility are the white and red pine, annually exported in large quantities to the United States and to Europe. Three-fourths of the square and flatted timber produced in the Ottawa region in 1873 was of white pine. Cedar, red pine, and railway-ties chiefly made of tamarac, were the others which were produced in largest quantities. Pine trees of 100 feet high are not uncommon; and instances are not rare of trees greatly exceeding that height.

The pine prepared for exportation is made into squared timber, measuring from 60 to 70 feet in length; or into waney timber (as it is called when only partially squared or flatted), averaging generally the same lengths though sometimes running to 100, or even 120 feet. For the native market the unsquared log is cut into convenient lengths of from 12 to 15 feet for the saw-mill. The white oak, besides being made into squared timber not greatly inferior in dimensions to the white pine, serves also largely to supply staves both for the English and the West Indian markets. The number of pieces of squared and flatted timber produced in the Ottawa district alone in 1873 was 303.268, and the number of unsquared logs for the same year amounted to 2,024,980. The elm, beech, ash, maple, walnut, cedar, birch, and tamarac are all valuable products of the Canadian forests. The black walnut and the birds'-eye and curled maples are now in special demand in England for cabinet and fancy work. The sugar maple is also of value for the sap which it yields during early spring, from which excellent sugar is made in ever-increasing quantities. The yield of maple sugar produced in the four older provinces in 1871 amounted to 17,276,000 lb. A maple grove, as it is called, is accordingly regarded as a valuable feature on a Canadian farm.

The value of the immense forests of Canada is becoming more apparent every year. The year 1874 was one of reduced exports and imports, as compared with any previous year since the confederation of the provinces. Nevertheless the total produce of the forest exported during that year, apart from what was required for use within the Dominion, amounted in value to $26,817,715. Of this timber to the value of $14,928,403 was exported to Great Britain; the United States received to the value of $9,654,890; South America to the value of $920,309; the British West Indies to the value of $602,487; and the remainder went to the Spanish, French, and Dutch West Indies, to France, Portugal, Belgium, Germany, and Holland, and to regions and colonies beyond the Pacific. Australia took to the value of $60,081; China, $38,024; British and Dutch Guiana, $23,452; and Honolulu, the Azores, South Africa, and other countries, in lesser proportions. In addition to all this, the forest produce required for home consumption during the same period cannot be estimated at a less value than $3,000,000.

Canada is becoming every year more important as an agricultural country. It is exporting not only grain but also cattle to the English market; and when the rich prairie lands of the North West are brought under cultivation its agricultural produce will probably rank foremost in value of that of any nation in the world. But at present the produce of the Canadian forests exceeds in value any other yield of the growth, produce, or manufacture of the Dominion. The total value of the exports of Canada for 1874 amounted to $73,926,748; and of this $26,817,715 was the produce of its forests. The importance of this branch of native industry cannot therefore be overlooked. The Governments of the different provinces grant licences to those engaged in the timber trade to cut timber over vast tracts of land, under the name of "timber limits." These are in most cases remote from the settlements; and much ability and foresight are required to make adequate provision for the large bodies of men, horses, and oxen, to be employed in cutting down and preparing the timber for the market, and transporting it to suitable points for rafting. Much capital is accordingly embarked in the trade. Hay and other requisites have to be accumulated at suitable stations. Large gangs of lumberers follow at the proper season. Lumber shanties are constructed capable of accommodating from 25 to 50 men. The structure is made of logs hewn on the spot, and forms a square or oblong edifice surrounded on three sides with the baulks, or sleeping-berths, of the men, while the fourth side is occupied by the dresser or working-table and other requisites of the cook. The centre is open to the sky, and underneath this only opening for light or air a huge wood fire is kept constantly replenished. Over it stretches the crane on which the cook hangs his pot; and thus the fire answers the double purpose of warming and ventilating the dormitory and cooking the food of its inmates. The shanty-cook is an important member of the little community. Salt pork and beef, pease-soup, wheaten bread and tea, with potatoes, white beans, and onions, are the staple of the lumber-shanty fare. As a rule, intoxicating liquors are absolutely excluded; and thus provisioned the foreman selects the proper trees, and lumbering operations proceed throughout the winter. Many thousands of men are busy through the whole winter felling the trees, cutting them into logs, or hewing them into squared timber, and transporting them over the snow to suitable points for floating them down the rivers to the mills, or directly to the place of export. As the rivers are in many places interrupted by falls of a character unfitted to the safe passage of timber over them, large sums are expended in constructing timber-slides; and on some of the main channels, as on the Ottawa, the construction and maintenance of the chief timber-slides are undertaken by the Government.

It is erroneously supposed by many, who are unfamiliar with the character of the Canadian forest, that the work of the lumberer results in the clearing of the land. Only the finest full-grown trees are selected for the lumberer's axe, and it is calculated that the same district may be gone over by the lumberer every twelve or fifteen years. Hence if the destructive fires which from time to time do such immense injury can be guarded against, and the operations of the lumberer are carried on with due care, under proper oversight, there is no reason why the forests of Canada should not remain a permanent source of national wealth.

In the new clearings in the vicinity of lumbering districts, the farmer finds a ready demand for all his produce, and employment for himself, his horses, and his oxen during the leisure of winter. In this way the lumbering business helps to promote the settlement of new districts, and attracts a population to localities which otherwise might long remain a wilderness. In free-grant districts, as in the Muskoka region on the Georgian Bay, where new settlers are engaged in their first hard struggle to transform the wilderness into fruitful farms, the earliest savings of the farmer are frequently expended on a yoke of oxen; and thus provided, his services are welcomed by the lumberers, and he can find profitable employment throughout the winter. On the breaking up of the frost in spring the produce of the winter's lumbering is floated down the rivers. There, at suitable points on every available rapid or waterfall, large mills are erected for sawing up the logs, chiefly for the English and American markets. The squared timber for the foreign markets is put together in cribs and run down the rivers to suitable points, where they are formed into great rafts, and so floated down the lakes and rivers, as on the River St Lawrence to Quebec. There they are finally broken up, and shipped for their foreign destinations.

Few among the many sights which meet the eye of a voyager on the St Lawrence are more striking than one of those floating villages, consisting often of 150,000 cubic feet of timber, bound together into one great raft, with its shanties, its blazing fires, securely kindled on an earthen hearth, and its banners streaming in gala fashion, as it glides along. Much skill is required in piloting these rafts down the great rivers. The cribs floated from the far inland timber limits are collected into what are called drams; each dram has its own gang or division of the raft's crew, and so many drams form a raft. But at every considerable rapid the raft is again broken up into its component parts, and the cribs taken down separately, to be again put together on reaching smooth water. Thus united, the raft moves onward with the current, aided at times by sail and oar, until it is safely secured within the booms of the great timber merchants in the coves above Quebec.

Animals.—Looking to the native fauna of Canada in an economic point of view, it is abundantly evident that the animal life of its seas and rivers is one of its great and inexhaustible sources of wealth. Alike on the sea-coasts, in the estuaries, and throughout its great inland lakes and rivers, the most valuable fish abound; and on the Labrador coasts and those of Newfoundland the seal fisheries are another annual source of wealth. The sturgeon is caught in Canadian waters, frequently weighing from 80 to 100 lb; the finest salmon abound both in the eastern rivers emptying into the Gulf of St Lawrence, and in those of British Columbia; lake trout is caught in large quantities weighing from 10 to 40 lb; and the smaller rivers and lakes teem with beautiful speckled trout, frequently weighing from 4 to 6 lb. The white fish and maskinonge are

esteemed for their delicacy and richness of flavour; and the returns of the fisheries, as given in the separate accounts of the various provinces, show the relative abundance of cod, haddock, mackerel, herring, salmon, halibut, white fish, and other produce of the Canadian fisheries.

The returns of the last census show that in 1871 Canada produced 82,844 quintals of cod and haddock, and 685,272 barrels of fish of various sorts, besides 678,894 gallons of fish oil; and the total value of the produce of the fisheries exported during the fiscal year 1874 was $5,292,368. The quantities here stated are exclusive of the valuable fisheries of Newfoundland, which employ large fleets, and yield a corresponding return from cod, salmon, herring, mackerel, and other fish, from the oil of the whale and cod, and from seal-skins.

Neither British Columbia nor Manitoba has yet been brought within the provisions of the Fisheries Act; and the total yield of their fisheries can only be approximately estimated. Valuable oyster beds exist on the Pacific coasts of the Dominion. The salmon fishery promises, if rightly protected and regulated, to prove a valuable branch of industry. During the year 1873, 195 tons of salmon were canned for export; and 4000 barrels were salted. In the great lakes and rivers of Manitoba the white fish are no less abundant; and they constitute an important source of supply of food in certain seasons of the year throughout the whole North West. The total value of the yield of the fisheries of the Dominion for the year 1874 was estimated at not less than $11,000,000.

Canada has been esteemed from its earliest discovery for its valuable fur-bearing animals, and was prized chiefly on this account so long as it remained a dependency of France. In 1670 Charles II. granted the charter to the Hudson's Bay Company, whereby they acquired the exclusive right of trading with the Indians in the vast regions vaguely recognized as surrounding the great inlet from which the company took its name. In 1783 a rival company was established under the name of the North-West Company, which claimed that, as the Royal Charter of their rivals had not been confirmed by Parliament, all British subjects were free to engage in the fur trade of the North-West The results of the jealousies and hostilities of the two companies played an important part in the early history of Canada, and in the first attempts at settlement on the Red River, which paved the way for the rise of the new province of Manitoba. After many bitter contentions, and after impeding each other's operations for years, the rival companies at length effected a junction in 1821; and the fur trade has since been successfully prosecuted under their joint action, till the acquisition by Canada of the north-west territory as a necessary step towards the prosecution of the plans of confederation, and the formation of new provinces throughout British America.

There still remains, however, not only a vast extent of unoccupied territory in which for many years to come the hunter and the trapper will find undisturbed sway, but the regions around the Hudson's Bay, and stretching westward to Alaska and northward to the pole, must ever remain a shelter for fur-bearing animals, and a resort of the hunter. All the furs collected for the great fur company are shipped to London:—in part from their factories of York Fort and Moose River, on the Hudson's Bay, which are visited by a ship from England every year, and in part from Montreal and Columbia River.

In the vicinity of Canadian clearings deer are still found in abundance, and venison is plentiful during winter in all the markets of Canada. But wherever the deer abound wolves are sure to follow; and wherever they occur sheep-farming is impossible, and their depredations on the farmer's stock make them an object of special dislike. In order to encourage their extermination a premium is paid by Government for the head or scalp of each wolf produced to a local magistrate, and it is not uncommon in new districts for the settler to pay his taxes in wolf scalps. By this means they rapidly disappear from the neighbourhood of the settlements. The bear is another mischievous native of the Canadian forests. The winter furs both of the bear and the wolf are prized for robes; and their value furnishes an additional stimulus to the extirpation of both wherever the country is settled. Beyond the settlements, in the remote recesses of the uncleared forest, the beaver still abounds. Foxes of diverse kinds (silver, grey, red, and black), racoons, otters, fitches, martins, and minks are no less abundant. The musk rat is to be met with on all the Canadian rivers; and the red, black and grey squirrels sport everywhere in the forest, and at times even invade the clearings and make free with the farmers' crops. In the more remote regions, now also being invaded by settlers, vast herds of buffalo are met with; and beyond them are the moose, the wapiti, the reindeer, the white Arctic fox and the polar bear, whose haunts are safe from the invasion of the settler, however rapidly the Dominion may extend, and carve out new provinces in the great wilderness of the North-West.

The total value of the furs exported from Canada in 1871 was $1,633,501. This is distinct from hides and other products of the farm. In the abstract of the value of goods, the growth, produce, and manufacture of Canada, exported from the Dominion during the fiscal year 1874, animals and their products are classed under one head, showing a total value of $14,679,169. This includes a classification of farm and dairy produce along with the products of the chase, the chief items of which may be stated as follows, the same being exclusive of all home consumption:—

Animals and their Produce.			Value.
Horses	number	5,399	$570,544
Horned Cattle	,,	39,623	951,269
Sheep	,,	252,051	702,504
Swine	,,	6,983	56,824
Poultry			79,224
Pork, Beef, and other meats	cwt.	300,003	2,172,591
Butter, Cheese, and Eggs			6,731,105
Lard and Tallow	lb	3,232,458	306,860
Hides, Pelts, Hams, and Hoofs			394,069
Wool	lb	2,764,796	983,845
Furs, dressed and undressed			1,633,501

Cultivated Land and Agricultural Products.—Canada is pre-eminently a country of yeoman farmers. The land is held in possession and tilled by the settler on his own account; and with every addition to the numbers of its industrious population fresh acres are recovered from the wilderness, and added to the productive resources and the wealth of the Dominion. The number of persons occupying land within the four provinces of Nova Scotia, New-Brunswick, Quebec, and Ontario according to the census of 1871 was in all 367,862. Of these there were 324,160 owners, 39,583 tenants, and only 2119 farm labourers or servants. Those facts alone suffice to illustrate the striking contrast between the condition of Canada and most of the countries of Europe. By patient industry and frugality it is in the power of every Canadian to become owner of a house, and proprietor of whatever amount of land he can turn to profitable account; while the character of the population resulting from this condition of things checks the accumulation of extensive landed estates in the hands of single proprietors. The majority of the farms are small, tilled by the proprietor with his own hands, with the help of his sons and occasional hired labour in the busy season

of harvesting. But capital is also successfully applied to farming, and beautiful large stock farms are now entering into rivalry with those of the United States and even of England. The following table shows the extent of holdings, and the subdivision of land:—

10 acres and under	40,281
10 „ to 50 acres	78,877
50 „ to 100 „	141,300
100 „ to 200 „	82,176
Above 200	25,228

The greater number of occupiers and owners of holdings of ten acres and under are to be found in Quebec and the Acadian settlements of the maritime provinces, where a continual subdivision goes on among families under the influence of old custom and the operation of the French law of inheritance. In Quebec the old French seigniories established and perpetuated a large class of landed proprietors with their tenant farmers; and notwithstanding the abolition of the seigniorial tenures in 1854, their influence still survives, so that the number of holders of land above 200 acres is greater in Quebec than in any of the other provinces. The climate and other attractions of Upper Canada tend to secure to it the largest share of immigration; and the rapidly increasing quantity of cultivated land in the province of Ontario is at once an evidence and a guarantee of the substantial progress of the country. In 1842 the population of Upper Canada numbered 486,055, with 1,927,816 acres of land under cultivation. In 1852 the population had increased to 952,004, and the land under cultivation to 3,697,724 acres. According to the census of 1871 the total population of Ontario, as it is now called, numbered 1,620,851, with 16,161,676 acres of land in process of improvement.

Besides the grand staple of the cereal grains, the Canadian farmer derives large returns from his crops of hay, clover, and grass seeds, carrots, mangel wurzel, beans, hops, flax, hemp, and tobacco. In 1852 Upper Canada produced 764,476 ℔ of tobacco, the greater portion of which was grown along the western shores of Lake Erie, and on the peninsula between that and Lake St Clair, where the soil and climate specially favoured its growth. At the same date Lower Canada produced 488,652 ℔; but in 1871 the returns for the province of Quebec alone amounted to 1,195,345 ℔ of tobacco. Hops are cultivated with still greater success; and flax and hemp are additional sources of profit to the farmer. The value of the hops, flax, and flax seed exported during the year 1874 amounted to $161,908. The following tabular statement of the values of some of the chief agricultural products exported during the year 1874, apart from the amounts retained by Canada for home consumption, will suffice to illustrate the increasing value of this important branch of native industry:—

Wheat	bushels	6,581,217	$8,886,077
Barley, Rye, and Oats	„	4,746,820	4,532,669
Indian Corn	„	235,864	81,224
Flour	barrels	540,317	3,194,672
Meal	„	53,162	230,820
Flax	cwt.	782,054	113,256
Flax and other Seeds	bushels	19,088	12,306
Peas and Beans	„	1,807,208	1,526,689
Hay	tons	26,725	293,210
Hops	℔	169,726	40,177
Bran	cwt.	13,898	27,992
Tobacco	℔	125,844	3,568
Fruit and Vegetables		...	460,993
			$19,403,653

The total value of the grain and other agricultural produce of Canada exported during the year 1874, apart from the produce for home consumption, was $19,590,142, of which Great Britain received to the amount of $9,867,047, the United States $8,680,997, and the remainder was distributed as shown here:—

Great Britain	$9,867,047
United States	8,680,997
France	159,600
Belgium	92,000
Newfoundland	595,909
British West Indies	37,427
Spanish West Indies	29,343
French West Indies	4,490
Danish West Indies	7,240
Dutch West Indies	1,373
St Pierre	64,164
Madeira	1,812
British Guiana	15,617
St Domingo	3,123
Total	$19,590,142

But a false estimate of the actual agricultural resources of Canada is apt to be produced by testing them by its exports. Canada is a country of yeoman farmers tilling their own lands and living in abundance on the produce. The requirements for the table of the farm labourer are on a scale consistent with the resources of the country. The home consumption is accordingly great as compared with the number of the population; and it is therefore impossible to estimate, even approximately, the total annual value of all kinds of produce resulting from agricultural labour within the Dominion.

Minerals.—The mineral resources of Canada have as yet been very partially developed. Quebec and Ontario are devoid of coal, though both have access by convenient transport to rich coal-fields in adjoining provinces or states; but the maritime provinces, Manitoba, the north-west territories, and British Columbia are all rich in coal. Other valuable mineral resources are still turned only to the most partial account; but as the work of the Geological Survey proceeds, new fields are opening up for enterprise every year. The rich silver ores of Lake Superior have already yielded wonderfully valuable results to the miners; and the neighbouring districts are now being carefully surveyed. Extensive tracts of gold-bearing quartz are also reported, and Mr Bell, who took the charge of the Geological Survey on Lake Superior in 1872, states that within the basin of the Neepigon, which extends to about 170 miles in length by 80 in breadth, the upper copper-bearing series obtains the greatest development. Distinct belts of rock extend from thence along the line of the lake coasts by Thunder Bay to Font du Lac; and in one of those, styled the Lake Shebandowan band, the gold-bearing rock is found. Gold-bearing veins are also reported to occur at Cross Lake on the Red River route; and far beyond the province of Manitoba, a rich copper region has long been known on the Mackenzie River.

As railways are extended, and the great project of a Canadian line from the St Lawrence to the Pacific is gradually made an accomplished fact, the resources of the regions traversed by it will be fully disclosed and turned to account. The vicinity of the great coal-fields of Pennsylvania and Michigan to Lake Erie and Lake Huron, must always give them an advantage in any competition for the supply of Ontario with fuel. But the development of the railway system of the Dominion cannot fail to render its own mineral resources available to a much larger extent, not only for home consumption but for exportation. The Intercolonial Railway has opened up an extensive country to the coal miners of Nova Scotia; and the like results will follow both in the north-west and in British Columbia, when the great coal-fields of those regions are traversed by roads and railways, and their fertile prairies and rich alluvial valleys are settled by an industrious population. At present Canada both exports and imports coal, though

the imports as yet greatly exceed the exports. The total produce of the mines of Canada, including coal, exported during the fiscal year 1874 amounted in value to $3,977,216. The following tabular statement shows the present resources of the Dominion, and its dependence on external sources for its supply of coal:—

Canadian Export and Import of Coal for 1874.

	Export in Tons.	Import in Tons.
Nova Scotia	360,184	67,349
New Brunswick	6,627	142,503
Prince Edward Island	219	696
Quebec	656	1,221,158
Ontario	...	2,372,250
Manitoba	...	665
British Columbia	50,671	696
Total	418,357	3,805,317

Trade of Canada.—The abstract of the value of the growth, produce, and manufactures of Canada, as shown by its exports, is classed in the official returns under six principal heads, viz., the mines, the fisheries, the forest, animals and their produce, agricultural products, and manufactures. The results show, by a comparison with the earlier statistics of the country, the rapid progress it has made in a single generation.

The trade of Canada at a period not very distant was confined chiefly to the exportation of furs, seal-oil, and timber, little exceeding £100,000 annually. Prior to the year 1759, when the country, with its population of 65,000 inhabitants, was transferred from the Government of France to that of England, the amount of its annual exports was £115,415. The principal trade was furs, in pursuit of which the great forests were traversed by bands of resolute adventurers. A few ships were occasionally built. Agriculture was neglected, if not actually despised.

Upon the acquisition of the country, however, by England, the cultivation of the soil attracted the attention of the settlers, and the germs of a trade sprung up which has now grown to be one of real magnitude and importance. In 1769 the exports in furs, oil, fish, &c., amounted to £355,000, and the imports in British manufactured goods and West India produce, reached £273,400. This trade employed seventy vessels; about twelve vessels were at the same period engaged in the fisheries of the St Lawrence, and about six were sent to the West Indies.

In 1799 and the three following years we find comparatively large exportation of grain taking place. In 1802, 1,010,000 bushels of wheat, 38,000 barrels of flour, and 32,000 cwts. of biscuit were sent abroad. The number of vessels at this period engaged in the trade of the colony was 211, the aggregate burden of which amounted to 36,000 tons. In 1809 the first steamboat appeared in the harbour of Quebec.

In 1809, 1810, and 1812, the trade of Canada, benefiting by increased duties levied upon Baltic timber imported into Britain, seems to have been comparatively active. In the first of these years 440 vessels, having an aggregate tonnage of 87,825 tons, arrived at Quebec. In 1810 as many as 635 vessels arrived in the St Lawrence, with an aggregate tonnage of 138,057 tons; and in the same year 26 vessels, having a tonnage of 5836 tons, were built in the province. In 1812, 532 vessels, with a tonnage of 116.687 tons, cleared at the port, 37 of which had been built at Quebec.

The war which commenced in 1812 between the United States and Britain severely checked the commerce of the St Lawrence, which was greatly dependent upon the Americans. And, notwithstanding that Britain slightly relieved the import duties on wheat in favour of Canada in 1814, we find that the trade of the colony from 1810 to 1820 remained almost stationary. The aggregate tonnage which arrived at Quebec in 1820 (a more prosperous year, if shipping be taken as the criterion, than any of the preceeding ten) amounted only to 9697 tons over that of 1810. In 1810, 26 vessels had been built in the colony, and only 7 were built in 1820.

According to the old system of colonial monopoly, the St Lawrence was rigidly closed against the entrance of foreign vessels, nor was any Canadian vessel allowed to enter a foreign port. The prosperity of the colony during this period of its infancy was believed not to have been materially checked by these restrictions, as the mother country at all times afforded an outlet for its surplus produce. After the United States had achieved their independence, their vessels were excluded from the ports of the British colonies; and Canada, as a reward for its loyalty, received the exclusive privilege of supplying the West India Islands with timber and provisions.

In this manner, as the trade of Canada had been confined and shackled for the supposed benefit of the mother country, so now she was rewarded with compensating privileges to the direct injury of the sister colonies of the West Indies. The United States ports were the natural resorts of the West Indies for timber and provisions, their distance from these being about one-half less than the ports of the St Lawrence. But the additional freight, which on such bulky articles constitutes a great proportion of the expense, was not only enhanced by this circuitous route, but the West Indies had to pay besides for transshipment upon what was supplied by the United States to Canada for the West Indian market. The West India planters were thus laid under contribution for the support of the Canadian shippers and farmers.

These regulations were, however, so far relaxed in favour of the West Indies in 1822, that the wheat and lumber of the United States were allowed to be imported directly on payment of certain duties; but at the same time duties were imposed upon agricultural produce entering the British American colonies as well as the West Indies.

The immediate result of this measure, so far as it affected Canada, was that one-half of the export trade of the St Lawrence was at once destroyed. The simultaneous abundance of the English harvest, together with the restrictions then in force upon the importation of grain into Britain, even from her own colonies, forbade any exports thither, and thus seriously aggravated the depression of Canadian commerce, and afforded another illustration of the ruinous policy of bolstering up one class by privileges and exemptions, and shackling another by restrictions and duties.

In 1825 Britain admitted Canadian flour and wheat into her ports at a fixed duty of 5s. sterling per quarter. Meanwhile a fresh trouble had already arisen to try the vexed fortunes of Canada. Previous to 1822, American exports had to a considerable extent sought the route of the St Lawrence, as if they had been of Canadian origin, contributing very materially, of course, to the benefit of the trade of the colony. But the opening of the Erie and Champlain canals in the United States, in 1825, drew off into a different channel those American exports which had formerly sought the Atlantic by way of Quebec, and the trade of the St Lawrence was thus seriously injured.

In 1826, however, the prospects again appeared to be brightening. The Americans were allowed, after four years of exclusion, to export timber and ashes for the British market into Canada free of duty. The duty upon Canadian flour for the West India market was also reduced.

The trade of the colony likewise profited by the disputes between Britain and the United States, which led to the

interdiction of the American export trade to the West Indies. This was reduced from £500,000 in 1826 to less than £500 in 1830. While the results were such to the United States, we find the trade of the St Lawrence in 1830 not only fairly recovered from the effects of the Imperial Acts of 1822, but far surpassing its position at any former period. The arrivals at Quebec in 1830 were 967 vessels, having a tonnage of 238,153 tons.

In 1831 the trade of the colony was still further favoured by the action of the Home Government. The forest and agricultural products of the United States were admitted into Canada free of duty, and could be exported by the St Lawrence, as Canadian produce, to all countries except the United Kingdom. A differential duty was also at the same time imposed upon foreign timber entering the West Indian and South American possessions, greatly to the benefit of the colony, which also profited by the scarcity of food existing in Britain at this time. The arrivals at Quebec during this favoured and prosperous year, were 1016 vessels, with a tonnage of 261,218 tons; and the exports of flour and wheat by the St Lawrence were about 400,000 barrels, chiefly to Britain.

Between 1831 and 1836 we find a complete reversal of the order of trade between the colony and the mother country. The crops in England during that period being unusually abundant, and a scarcity of bread-stuffs existing in the United States, wheat was, in 1833, shipped from Britain to Quebec. A supply also came from Archangel. These imports from Europe to the St Lawrence amounted in 1835 and 1836 to about 800,000 bushels. The relaxation by the mother country of her protective policy in 1842 was viewed with alarm by the colonists as fraught with disastrous consequences to their interests. Up to 1842 Baltic timber had paid an English import duty of 55s. per load, while Canadian timber entered England upon payment of 10s. per load. The duty on foreign timber was now reduced to 30s. and Canadian to 1s. per load. At the same time the free importation of United States flour into the colony was stopped, and the West Indies were allowed, on the payment of a duty of 2s. per barrel, to import their flour direct from the Americans.

These serious blows to the trade of the St Lawrence fell upon the colony at the period of a commercial crisis, and were therefore felt more severely. The number of vessels that entered the St Lawrence in 1842, from the sea, was 377 less than during the previous year.

In 1843, Canada was allowed to import American wheat under a comparatively nominal duty, and to export it through the St Lawrence as native produce to the British market. This measure, which may be viewed as having been the first indirect blow at the English corn-laws, amounted to a virtual premium of about 6s. sterling per quarter upon American exports to Britain through the St Lawrence. The British ports were thus at once in a great measure thrown open to all the great wheat-growing countries of North America. Canadian exports were rapidly swelled in consequence; and in 1846 half a million of barrels, and as many bushels of wheat and flour, were shipped by the St Lawrence. The timber trade of the colony, which was also seriously threatened in 1842 by the large reduction of the duty on Baltic timber imported into England, witnessed likewise in 1845 and 1846, not merely a revival, but a very material increase. The number of vessels that entered the St Lawrence rose to 1699 during each of these years, with an aggregate burden of over 620,000 tons,—this being a much larger amount of shipping than had ever in any previous year entered the St Lawrence.

The history of Canadian trade enters upon a new stage from 1846, when the commercial policy of England at length relaxed the old restrictive navigation laws in reference to her colonial possessions. One of the most practical evidences of its beneficial influence on Canadian trade is shown in the increase of its traffic with the United States, at the very time that its trade relations with the mother country were being annually augmented in a corresponding ratio. From 1821 to 1832, the aggregate annual traffic between the United States and Canada averaged no more than $3,257,153. From 1833 to 1845 the average increased, with the growing population, industry, and wealth of both countries, to $6,313,780 per annum. But under the influence of the more liberal policy inaugurated by Great Britain in 1846, the traffic rose between that year and 1853 so rapidly that its annual average amounted to $14,230,763.

But the concessions made by the mother country in favour of the timber and corn trade of Canada were still only partial. The exportation of colonial produce from the St Lawrence could only be carried on in British vessels; and thus there grew up a class of vessels specially appropriated to this trade, which made only two voyages in the year to Quebec or Montreal; and these having a monopoly of the whole exports of the St Lawrence at privileged rates, the colony was virtually subjected to a heavy tax both on its exports and imports. Tea, coffee, sugar, and all the manufactured articles still required to be obtained from abroad were thus only obtainable through English ships; and hence the Canadian merchant was greatly restricted in the choice of the best and cheapest market. In return, however, the colonists had certain privileges accorded to them, foremost amongst which were those already referred to in connection with the import of wheat from the United States, and its export from the St Lawrence as native produce,—the Canadian merchants having an advantage thereby over their competitors in New York and other American ports.

The abolition of the British corn laws deprived Canada of the privileges thus accorded to her in the export of bread-stuffs, and seemed to threaten the trade of the St Lawrence with grievous discouragement at the very time when the transactions of the colony with the United States were in a great measure interdicted by a hostile tariff. The changed and more enlightened views, however, which entered into imperial legislation materially assisted the growing energies and intelligence of the colonists. The Imperial Government formally abandoned in 1847 all control over the customs of the colony, which immediately set itself to the task of regulating its own trade. One of the first measures of the colonial legislature was to abolish in a great degree the differential and prohibitory duties on colonial imports along the United States frontier; and the Americans upon the other side of the St Lawrence were by this measure placed, as regards matters of trade, upon an equal footing with England. The beneficial effects of this measure showed itself at once in increased commercial activity and prosperity over the whole of Canada.

On the 1st of January 1850, England completed her free trade measures by relieving the colonies from the injurious effects of the British navigation laws. The value of the more enlightened views which thus entered into both imperial and colonial legislation has since been most satisfactorily tested in the growing wealth and prosperity which have attended the progress of the colony. The same year is memorable for other events affecting Canadian progress. It was in 1850 that gold was first discovered in British Columbia, and coal at Nanaimo, on Vancouver Island; and so the steps were accelerated which led to the organization of the first province of the Dominion on the Pacific. The same year was marked by the organization of the opposition to ecclesiastical endowments, as well as to

other exclusive rights and privileges, which resulted in 1854 in the final settlement of the vexed questions of the clergy reserves and seigniorial tenures in Upper and Lower Canada. The Grand Trunk Railway, which had been commenced in 1847, was now hastening to completion. Nova Scotia had already its first railway; the important local line connecting the Georgian Bay with Toronto, was developing the resources of Upper Canada; and in the same year, 1854, the Great Western Railway was commenced. By this line Toronto is not only placed in direct communication with Detroit, Chicago, and the whole Western United States; but by the extension of the line from Hamilton to the vicinity of the Niagara Falls, and the construction there of a suspension bridge, on a grand scale, for railway as well as ordinary traffic, the Great Western Railway of Canada has become an important link in the main lines of transit from Boston and New York to the Western States. Since then the building of railways and the development of railway traffic have been energetically prosecuted. The Intercolonial Railway has been completed, as a material bond of union between the older provinces of Canada and the maritime provinces, and a route through Canadian territory, at all seasons, to the seaboard. This has been followed by the more comprehensive scheme of a Canadian Pacific Railway, the surveys for which have been already made; and its first links are now in process of execution. The actual mileage of the railways within the Dominion completed, up to the close of 1874, extended to 4022 miles. The following tabular view of the railway traffic returns for the two previous years will suffice to illustrate their influence on the rapid growth of Canada in recent years:—

Railways.

Railways.	Total 1873.	Total 1872.	Miles 1873.	Miles 1872.
	$	$		
Brockville and Ottawa (7 months)...	281,451¼	232,209	86	86
Canada Central (6 months)........	54,012¼	49,509	28	28
Carillon and Grenville (no return for 1873)	...	...	12¾	12¾
Cobourg, Peterboro' and Marmora (6 months........	51,785	41,653	22	22
European and North American (no return for 1873)........	...	256,169	108	108
Great Western	5,618,239	4,960,317	351¼	351¼
Grand Trunk........	9,342,223	8,531,890	1,377	1,377
Intercolonial	821,424	241,464	269	261¼
London and Port Stanley (no return for 1873)	...	39,808	24¼	24¼
Midland of Canada (7 months)........	179,948¼	[1]261,737	89	89
Northern do (6 months)	401,950	[2]589,728	141	120
New Brunswick and Canada (3 months)	51,180¼	[3]15,909	128	124
St Lawrence and Ottawa	183,278	158,149	54	54
St Lawrence and Industry (7 months)	12,703¼	[4]6,628	12	12
Toronto and Nipissing (3 months)...	53,382¼	...	88	...
Toronto Grey, and Bruce (no return for 1873)	...	...	...	...
Windsor and Annapolis (no return for 1873)	...	...	...	...
Welland (9 mos.)	101,643	[5]50,829	25	25
Total........	17,139,876	15,436,018	2,638¼	2,508¼

[1] 8 months. [2] 10 months. [3] 1 month. [4] 5 months. [5] 5 months.

Telegraphs.

During the same period telegraphic lines of communication have been no less energetically prosecuted. At the end of 1874 the Montreal Telegraph Company had 23,267 miles of wire, and 1288 different offices; and to both additions are being rapidly made. The Dominion Telegraph Company, more recently organized, with its head-office in Toronto, had at the same date 6000 miles of wire, connecting 300 different offices; and the British Columbia Telegraph, which was assumed by the Dominion Government, at the admission of British Columbia into the confederation, had already placed the head office at Victoria in communication with twenty-one offices, the remotest of which was then distant 557 miles.

Banks.

No less important is the banking system of the Dominion. From the banking returns published in the *Canada Gazette* it appears that the banking capital has more than doubled since 1870, and this by a steadily progressive increase. The tables are imperfect, owing to some of the banks having omitted to make the requisite returns; so that, while the following tabular statement illustrates the progressive rate of increase, it falls short of the full amount:—

Banking Capital of Canada.

1870....................	$29,801,013
1871....................	36,415,390
1872....................	45,134,609
1873....................	55,102,959
1874....................	60,443,445

Besides the Post-Office Savings Banks, established on the same principle as those in Great Britain, there are local and other savings banks, building and other societies,—and the admission of every new province adds to the number of such societies,—in all of which large amounts are deposited at interest, without accessible returns. The building societies advance funds for the erection of churches, halls, and other public buildings, as well as for private dwelling-houses; and the majority of the residents in cities and towns are proprietors of the houses which they occupy. The following tabular statement affords an illustrative view of the accumulating fruits of industry within the Dominion.

Bank Deposits.

Post-Office Savings' Banks..................	$3,587,365
Government Savings' Banks	3,862,676
Montreal City and District Banks	4,303,509
Caisse d'Economie de Notre Dame........	2,732,055
Chartered Banks..............................	78,790,367
Total..................	$93,275,972

Summary.—The evidence of the prosperity, and growing wealth of Canada may be completed in a tabular view of its exports and imports for two successive years, as derived from the latest official returns. The immediate result of confederation was a rapid progress in many ways. New railways were projected and brought into operation; new lines of steamships were established; fresh avenues of native and foreign trade were diligently sought out; and a succession of prosperous years was marked by a steady commercial expansion which attained its maximum in 1873. Since that date various causes, and especially the difficulties created by an unredeemable paper currency in the neighbouring United States, have tended to bring about a reaction; but it is a mere temporary ebb of the advancing tide, in which the commercial world at large has shared.

The following is a reproduction of a condensed comparative statement of the Commissioner of Customs, as given in the trade and navigation tables for 1874; to which are added from more recent unpublished returns, those of the year 1875, showing the influence of a period of reaction and great depression, alike on the exports and imports of the country.

Fiscal Year.	Total Exports	Total Imports	Entered for Consumption.	Duty.
1868........	[illegible]	[illegible]	[illegible]	[illegible]
1869........	[illegible]	70,415,165	[illegible]	[illegible]
1870........	[illegible]	[illegible]	[illegible]	[illegible]
1871........	74,173,618	[illegible]	[illegible]	[illegible]
1872........	[illegible]	[illegible]	[illegible]	[illegible]
1873........	[illegible]	[illegible]	[illegible]	[illegible]
1874........	[illegible]	[illegible]	[illegible]	[illegible]
1875........	[illegible]	[illegible]	[illegible]	[illegible]
Aggregate (of Eight Years)	[illegible]	[illegible]	[illegible]	[illegible]

The apparent annual increase shown in the above table, is modified by the following elements, which must be taken into account. The first three years represent the business only of the first four provinces of the Dominion. Manitoba was received into the confederacy in 1871; and the

statistics of that year include six months' returns from the new province, amounting to $254,063 total imports, $286,337 entered for consumption, and $15,723·22 duty collected. In 1872 the exports of Manitoba were valued at $85,541, the imports at $942,247, and entered for consumption, $1,020,172, on which $46,839·90 duty was collected. In the same year the returns for British Columbia appear as follows:—exports, $1,912,107; imports, $1,790,352; entered for consumption, $1,767,068; duty collected, $342,400·48. In 1874 the returns of Prince Edward Island give the following additional elements to swell the aggregate amount:—exports $722,129; imports, $1,908,522; entered for consumption, $1,913,696; duty collected $219,458·07. Deducting those sums and values from the years named, there remains abundant evidence of a steady and rapid increase in the commerce of the four older provinces up to the year 1874, when the depression prevailing in the United States, in part due to reaction resulting from the effects of the southern war, began to be felt in Canada as well as in other countries. The great expansion which has taken place in the commerce of Canada since 1867, and the influence of the reaction of 1874, are shown in the following consecutive statement of the joint value of exports and imports for the years from 1868 to 1875 inclusive:—

Exports and Imports.

1867–68	$131,027,532
1868–69	130,889,946
1869–70	148,387,829
1870–71	170,266,589
1871–72	194,070,190
1872–73	217,801,203
1873–74	217,565,510
1874–75	201,116,963

The relative wealth and progress of the different provinces of the Dominion will be illustrated by the following comparative table, showing the last year of nearly unchecked progress, and the first of reaction. It shows the value of the goods exported from, and entered for consumption in the Dominion, during the years ending the 30th June 1874 and 1875:—

Province	Year 1873–4.			Year 1874–5.		
	Exports. Value.	Entered for Consumption.		Exports. Value.	Entered for Consumption.	
		Value.	Duty.		Value.	Duty.
Nova Scotia	$7,656,547	$10,875,140	$1,409,094	$6,968,139	$10,688,213	$1,490,548·77
New Brunswick	6,503,934	10,321,492	1,399,930·75	6,542,829	9,855,533	1,370,611·42
Prince Edward Island	722,129	1,913,696	219,458·07	1,307,590	1,984,278	316,976·49
Quebec	46,393,845	51,981,127	6,613,509·50	39,801,041	50,618,588	6,772,303·90
Ontario	25,157,087	48,375,522	4,361,236·06	20,016,101	42,781,076	4,808,074
Manitoba	794,762	1,853,659	67,471·97	588,958	1,227,890	171,430·86
British Columbia	2,120,624	2,048,336	336,494·47	2,824,712	2,487,293	413,991·50
Total	$89,351,928	$127,368,972	$14,407,194·82	$78,048,870	$119,622,871	$15,343,931·94
Export Duty	...	...	14,564.90	...	...	7,231·86
			$14,421,759·72			$15,351,163·80

Administration of Justice.—So long as Canada consisted of the two provinces of Upper and Lower Canada, even when united for legislative purposes they retained their diverse laws and distinct judicial systems, while the Privy Council of Great Britain constituted the final court of appeal for both. In the province of Quebec the old French law, which was introduced under Louis XIV., is still the basis of the law of property. There the tenure of property remained strictly feudal, until the settlement of the claims of the seigniories by the Act of 1854 brought the old system to an end. But before that was effected new townships had been surveyed, and land disposed of to settlers to be held in free and common soccage. The commercial law is regulated partly by the old French code, but modified by the English customs, and by later Canadian legislation. The criminal laws of England, and the right of trial by jury, were introduced by 14th Geo. III c. 83. Since then all additions to the criminal law, or modifications of the statutes, have depended on the Acts of the colonial legislature. The religion, laws, language, and customs of the French population were all guaranteed to them at the time of the cession of Canada to England; and the rights and privileges pertaining to the Roman Catholic Church, among a population regarding its creed as their national religion, help to perpetuate essential differences, by maintaining what is still practically an established if not a state church.

By the constitution of the Dominion, as embodied in the British North American Act of 1867, the criminal law, with the establishment, maintenance, and management of penitentiaries; all laws relating to bankruptcy and solvency, marriage and divorce, naturalization, aliens, Indians, and Indian reserves; and generally, all subjects not expressly assigned to the provincial legislatures, pertain to the Dominion parliament. The judges in all the provinces are appointed by the general Government; and the pardoning power is vested in the governor-general *per se*, whilst his authority in all other respects is exercised under the advice of his privy council, or ministers for the time being. The powers entrusted to the local legislatures include generally all strictly local legislation not affecting in any way the rights of other provinces. The judges by whom the laws are administered must in the case of Quebec be selected from the bar of that province; and the judges of the superior courts in all the provinces hold office during good behaviour, and are removable by the governor-general on address of both houses of Parliament.

The rights and privileges of each province being thus secured by its own parliament and courts of law, the provisions of the Act of Confederation have been completed by the establishment of a Supreme Court and Court of Exchequer at Ottawa, consisting of a chief justice and five other judges, two of whom, including the chief justice, have been selected from the bench of Ontario, two from the bench and bar of Quebec, and one each from the bench or bar of Nova Scotia and New Brunswick. The court thus constituted is the supreme and final court of appeal, from all the courts of law in the various provinces,—with this exception that, while no appeal lies from the Supreme Court at Ottawa to the Privy Council, litigants have still the right of choice between the two as their final court of appeal.

Education.—Almost from the first organization of Upper Canada as a separate province, steps were taken for providing means for the establishment of efficient schools and colleges. So early as 1797 a grant of 500,000 acres of the unoccupied lands of the province was set apart for the purpose of establishing and endowing a university and four royal foundation grammar schools. Of this one half was appropriated as a university endowment, and one-fourth

of the remainder was granted to Upper Canada College, which assumed in Canada the functions of the great public schools of England, and still continues to hold its place at the head of the grammar or high schools of the province.

In the earlier years of Upper Canada, the "Clergy Reserves," set apart originally for the support of a "Protestant" clergy, were appropriated exclusively by the ministers of the Church of England. Upper Canada became an archdeaconry of the diocese of Quebec; and the venerable Archdeacon Strachan, whose first labours in Canada had been as master of the Cornwall Grammar School, became the leader both in ecclesiastical and educational matters, and ultimately a privy councillor, member of the legislative council, and bishop of the diocese of Toronto. He was a man of great energy and decision of character; and under his guidance the lands set apart for the endowment of a provincial university were appropriated to the purpose, and a royal charter was granted by George IV. establishing at Toronto, or York, as it was then called, "one college, with the style and privileges of an university, for the education and instruction of youth and students in arts and faculties," under the name of King's College. The bishop of the diocese became, *ex officio*, visitor; and when at length the college was organized, it had its divinity faculty, and its professor of divinity, along with its daily religious services according to the use of the Church of England. The special denominational character thus given to the provincial university excited opposition, and led to the establishment of Queen's College, at Kingston, under the control of the Church of Scotland, and of Victoria College, Cobourg, under the Wesleyan Methodist Church. To those have since been added Albert College, Belleville, under the management of the Episcopal Methodist Church; and Ottawa College, and Regiopolis College, Kingston, in connection with the Church of Rome. All of those possess university powers, either by Royal Charter, or by Acts of the provincial legislature. By subsequent enactments the constitution of King's College has been greatly modified. Its divinity faculty has been abolished, all denominational restrictions have been removed, and its functions divided between a university proper, modelled after the university of London, with a senate, on which devolves the fixing of the requirements for degrees, the appointment of examiners, and all other university work, as distinct from teaching. The latter is under the conduct and regulation of the professors, who constitute the council, of University College, and undertake all the duties of preparing the under-graduates for the university examinations in arts and science. Other colleges and schools, both in the faculty of arts and in those of law and medicine, are affiliated to the university, and part of the funds at the command of the senate is appropriated for scholarships, to be competed for at the examinations in the different faculties. On the passing of the Act of 1853, by which the divinity faculty and professorship were abolished, a royal charter was obtained for the establishment of Trinity College, in connection with the Church of England, with all the powers of a university

The system of public instruction for Ontario has hitherto been carried out under the direction of a permanent officer, styled the Chief Superintendent of Education, with the advice of the Council of Public Instruction, originally nominated by the Crown, but latterly including representatives of the universities, of the school inspectors, and the masters of high and public schools. But by a recent Act of the Ontario Legislature, the functions of the Council of Public Instruction have been transferred to a committee of the executive council; and the functions and duties of the chief superintendent are vested in one of its members, to be designated the Minister of Education. The introduction of the representative element into the Council of Public Instruction was immediately followed by a conflict between that body and the officers of the department in reference to various proposed modifications; and the changes now introduced aim at bringing the administration of the system of education more directly under the control of the people through their representatives.

There are two normal schools for the training of teachers, one at Toronto, and one at Ottawa; and it is proposed to establish others at Kingston and London. The high schools are divided into (1) collegiate institutes and (2) high schools for teaching classical and English subjects, and (3) high schools, in which instruction may be limited chiefly to English subjects. Of those there were 108 in all, including 8 collegiate institutes, in 1875, with an attendance of 8437 pupils.

The primary schools for junior pupils are styled public schools. The school population, including those between 5 and 16 years of age, was returned in 1874 as numbering 504,869. At the same date there were 4732 schools in full operation, with an attendance of 460,984 pupils. In all the above schools every feature of a denominational character is excluded. The collegiate institutes and high schools are under the control of trustees appointed by the county municipalities, and their maintenance depends on their share of the legislative grant and endowments, supplemented by the annual assessments of the city and county municipalities. The public schools are in like manner supported by legislative grants, and by assessments levied on the requisition of the school trustees in each school section. The essential feature of the whole system is that the people, directly or through their representatives, have the entire control of the schools, including the selection of the teachers, the fixing of their salaries, and the management of the school funds.

The one exceptional feature is the Roman Catholic separate schools. Any Roman Catholic can require his school-tax to be paid for the maintenance of the separate schools of his own church; and with this fund, supplemented from other sources, there were, in 1875, 170 separate schools in Ontario, with an average attendance of 11,123 pupils, or of 22,073 on the school rolls. According to the proportion of the Roman Catholic population, this is less than a third of their children of school age. A large proportion of the remainder attend the public schools. Masters of high schools are required to be graduates of universities, and to have had previous experience in teaching. Teachers of public schools must hold a normal school or other recognized certificate of qualification.

The principal features of the system of education thus brought into efficient operation have been modelled on those of the states of New York and Massachusetts, and on the normal schools of the Irish National Board of Education. The systems of the other Canadian provinces, with the exception of Quebec, have been framed on this model. In the last-named province, where the great mass of the people are Roman Catholics, the education is in the hands of the clergy, and is avowedly carried on in connection with the Church of Rome. But dissentient or Protestant schools are recognized as a part of the public school system, and the permanency of this state of things is guaranteed by a clause in the Act of Confederation, which excludes it from the interference of the general legislature.

General Remarks.—The position which Canada now occupies as a Dominion formed by a confederation of self-governing provinces, united under a central Government, with its own governor-general, cabinet ministers, senate, parliament, and supreme courts of law,—yet nevertheless remaining an integral part of the British Empire, and

acknowledging the sovereignty of its Queen,—is unique in the history of nations, and strikingly illustrates the adaptability of British institutions to the novel requirements of a free people. The peculiar circumstances resulting from the union of a colony formed under the fostering restraints of French ecclesiastical and civil rule with one of purely English origin, and settled in part by loyalist emigrants from the United States, begot difficulties which were more and more felt as the mother country removed from Canada one after another of the restrictions on self-government. It will form an interesting chapter in the history of Britain in relation to her colonies, to note the freedom with which, when those of British North America had, as it were, attained their majority, they were left to frame a scheme of confederation suited to their circumstances; and when, after free deliberation, it had been matured to the satisfaction of those most directly interested in the results, the Imperial Government received it at their hands, and the British Parliament gave it the force of law. At the very period when this novel experiment in the history of colonization had been carried out to completion, and was open to the test of experience, the vice-regal duties were entrusted to the earl of Dufferin as governor-general of Canada. In the exercise of his duties he has visited many portions of the Dominion; and towards the close of an extensive tour in the summer of 1874, he thus gave expression to the results of his observations:—"Everywhere I have learnt that the people are satisfied,—satisfied with their own individual prospects, and with the prospects of their country; satisfied with their Government, and the institutions under which they prosper; satisfied to be the subjects of the Queen; satisfied to be members of the British Empire. Indeed, I cannot help thinking that, quite apart from the advantage to myself, my early journeys through the provinces will have been of public benefit, as exemplifying with what spontaneous, unconcerted unanimity of language, the entire Dominion has declared its faith in itself, in its destiny, in its connection with the mother country, and in the well-ordered freedom of a constitutional monarchy. It is this very combination of sentiments, which appears to me so wholesome and satisfactory. Words cannot express what pride I feel as an Englishman in the loyalty of Canada to England. Nevertheless I should be the first to deplore this feeling, if it rendered Canada disloyal to herself,—if it either dwarfed or smothered Canadian patriotism, or generated a sickly spirit of dependence. Such, however, is far from being the case. The legislation of the Parliament of Canada, the attitude of its statesmen, the language of its press, sufficiently show how firmly and intelligently its people are prepared to accept and apply the almost unlimited legislative faculties with which it has been endowed; while the daily growing disposition to extinguish sectional jealousies, and to ignore an obsolete provincialism, proves how strongly the young heart of the confederated commonwealth has begun to throb with the consciousness of its national existence. At this moment not a shilling of British money finds its way to Canada; the interference of the Home Government with the domestic affairs of the Dominion has ceased; while the imperial relations between the two countries are regulated by a spirit of such mutual deference, forbearance, and moderation, as reflects the greatest credit upon the statesmen of both. Yet so far from this gift of autonomy having brought about any divergence of aim or aspiration on either side, every reader of our annals must be aware that the sentiments of Canada towards Great Britain are infinitely more friendly now than in those early days when the political intercourse of the two countries was disturbed and complicated by an excessive and untoward tutelage; that never was Canada more united than at present in sympathy of purpose, and unity of interest with the mother country, more at one with her in social habits and tone of thought, more proud of her claim to share in the heritage of England's past, more ready to accept whatever obligations may be imposed upon her by her partnership in the future fortunes of the empire." (D. W.)

CANAL

NAVIGABLE canals may perhaps be most conveniently treated under two classes, *Barge* or *Boat* Canals, now in many cases almost superseded by railways and *Ship* Canals, which, judging from the stupendous works of this class recently executed and now in contemplation, seem as yet far from having exhausted the important aids they are destined to afford to navigation.

After giving a historical notice of early canals, the following article contains a brief notice of Barge Canals; a digest of general engineering principles applicable to the construction of all canals; an account of Ship Canals recently constructed; and a notice of Ship Canals which have been proposed and are ere long likely to be carried into execution for facilitating ocean navigation.

rly his- y.

From the writings of Herodotus, Aristotle, Pliny, and other ancient historians, we learn that canals existed in Egypt before the Christian era; and there is reason to believe that at the same early period artificial inland navigation also existed in China. Almost nothing, however, save their existence has been recorded with reference to these very early works; but soon after the commencement of the Christian era canals were introduced and gradually extended throughout Europe, particularly in Greece, Italy, Spain, Russia, Sweden, Holland, and France.

In speaking, however, of the earliest of these works, it is not to be supposed that they resembled the modern canals now constructed in our own and other countries. Early as inland navigation was introduced, it was not until the invention of canal-locks, by which boats could be transferred from one level to another, that inland navigation became generally applicable and useful, and it has been truly remarked "that to us, living in an age of steam-engines and daguerreotypes, it might appear strange that an invention so simple in itself as the canal-lock, and founded on properties of fluids little recondite, should have escaped the acuteness of Egypt, Greece, and Rome."[1] Not only, however, had the invention escaped the notice of the ancients, but what is more striking, the several gradations made towards the attainment of that simple but valuable improvement appear to have been so gradual that, like many discoveries of importance, great doubts exist as to the *person* and even the *nation* that was the first to introduce canal-locks. One class of writers attributes the discovery to the Dutch, and Messrs Telford and Nimmo, who wrote the article "Inland Navigation" in Brewster's *Edinburgh Encyclopædia*, adopt the conclusion that locks were used in Holland nearly a century before their application in Italy; while, on the other hand, the invention has been strongly and not unreasonably claimed for engineers of the Italian school, and in particular for Leonardo da Vinci, the celebrated engineer and painter.[2] Without, however, entering into a discussion of this question, which it is now perhaps impossible to solve, we may safely state that during

[1] *Quarterly Review*, No. cxlvi. p 281

[2] Frisi *On Canals*, p. 154.

the 14th century the introduction of locks, whether of Dutch or Italian origin, gave a new character to inland navigation, and laid the basis of its rapid and successful extension. And here it may be proper to remark, that the early canals of China and Egypt, although destitute of locks, do not appear to have been on that account formed on a uniformly level line, unadapted to varying heights. It is very doubtful, indeed, if the use of locks has even yet been introduced into China, intersected as it is by many canals of great antiquity and extent, the imperial canal being about 1000 miles in length. "This canal appears to have been completed in 1289, and is said to extend for a distance of forty days' navigation, and is provided with many sluices, and when vessels arrive at these sluices they are hoisted by means of machinery, whatever be their size, and let down on the other side into the water."[1] Nevertheless the invention of locks was, as has been stated, a most important step in the history of canals; and that mode of surmounting elevations may be said to be almost universally adopted throughout Europe and America. Inclined planes and perpendicular lifts have, it is true, been employed in those countries, as will be noticed hereafter; but the instances of their application are undoubtedly rare.

Languedoc Canal.

But without tracing the gradual introduction of canals from country to country, we remark at once that we find the French at the end of the 17th century, in the reign of Louis XIV., forming the Languedoc Canal, designed by Riquet, between the Bay of Biscay and the Mediterranean, a gigantic work, which was finished in 1681. It is 148 miles in length, and the summit level is 600 feet above the sea, while the works on its line embrace upwards of one hundred locks and fifty aqueducts, an undertaking which is a lasting monument of the skill and enterprize of its projectors; and with this work as a model it seems strange that Britain should not, till nearly a century after its execution, have been engaged in vigorously following so laudable an example. This seems the more extraordinary, as the Romans in early times had executed works in England, which, whatever might have been their original use, whether for the purposes of navigation or drainage, were ultimately, and that even at an early period, converted into navigable canals. Of these works we particularly specify the Caer Dyke and Foss Dyke cuts in Lincolnshire, which are by general consent admitted to have been of Roman origin. The former extends from Peterborough to the River Witham near the city of Lincoln, a distance of about 40 miles; and the latter extends from Lincoln to the River Trent, near Torksey, a distance of 11 miles.

Foss Dyke.

Of the Caer Dyke the name only now remains; but the Foss Dyke, though of Roman origin, still exists, and as it is the oldest British canal, the reader may be interested to learn the following facts as to its history. Camden in his *Britannia* states that the Foss Dyke was a cut originally made by the Romans, probably for water supply or drainage, and that it was deepened and rendered in some measure navigable in the year 1121 by Henry I. In 1762 it was reported on by Smeaton and Grundy, who found the depth at that time to be about 2 feet 8 inches.[2] They, however, discouraged the idea of deepening by excavation. They say they found "the bottom to be either a rotten peat earth, or else a running sand," and that though the deepening of the navigation is in "nature possible," yet it "cannot be effected without removing one of the banks in order to widen the same," which would not only turn out expensive, but would "occasion much loss of time and profit to the proprietor while the work is executing." Nothing followed on this report; but in 1782 Smeaton was again called in, and deepened the navigation to 3 feet 6 inches, not, however, by widening the canal or dredging, but by raising the water-level 10 inches.[3] From that period nothing more was done to enlarge the water-way, or adapt it to increased traffic. Meantime the adjoining Witham navigation having been improved, the defects of old Foss became more apparent, and in 1838 Mr Vignoles was consulted, and made an elaborate report on alternative schemes for increasing the depth to 4 and 6 feet: nothing, however, was done till 1840, when Messrs Stevenson were employed to design works for assimilating the Foss Dyke as far as practicable, both as regards width and depth, to the navigable channel of the Witham. The depth was found to be 3 feet 10 inches, and its breadth in many places was insufficient to admit of two boats passing each other, and for their convenience occasional passing places had been provided. It was resolved to increase the dimensions of the canal, and to repair the whole work. Accordingly it was widened to the *minimum* breadth of 45 feet, and deepened to the extent of 6 feet throughout. The entrance lock communicating with the River Trent at Torksey was renewed, and a pumping engine was erected for supplying water from the Trent during dry seasons, and thus that ancient canal, which is quoted by Telford and Nimmo as "*the oldest artificial canal in Britain*," was restored to a state of perfect efficiency, at a cost of £40,000, and now forms an important connecting link between the Trent and Witham navigations.

Bridgewater canals.

Notwithstanding the existence of this early work, however, and of some others in the country, particularly the Sankey Brook navigation, opened in 1760, it cannot be doubted that the formation of the Bridgewater Canal in Lancashire, the Act for which was obtained in 1759, was the commencement of British Barge Canal Navigation, of which we propose first to treat, and that Francis, duke of Bridgewater, and Brindley the engineer, who were its projectors, were the first to give a practical impulse to a class of works which, under the guidance mainly of Smeaton, Watt, Jessop, Nimmo, Rennie, and Telford, has been very generally adopted throughout the country, and has undoubtedly been of vast importance in promoting its commercial prosperity.[4]

According to Mr Smiles, the barge-canals laid out by Brindley, although not all executed by him, were:[5]—

	Miles.
The Duke's Canal, Longford Bridge to Runcorn	24
Worsley to Manchester	10
Grand Trunk, from Wilden Ferry to Preston Brook	88
Wolverhampton	46
Coventry	36
Birmingham	24
Droitwich	5
Oxford	82
Chesterfield	46

[1] *Travels of Marco Polo*, by Col. Yule, C.B.
[2] Smeaton's *Reports*, vol. i. p. 55, London, 1812.

feet above the river, the canal being carried across in a cast-iron trough.[1]

It must be obvious, that to construct a navigable channel through a country varying in level, and affording, perhaps, no great facilities for obtaining a supply of water, infers high engineering skill. Vast reservoirs must in some cases be formed for storing the water necessary to supply, during dry seasons, the loss by lockage, leakage, and evaporation. Feeders must be made to lead this water to the canal, hills must be pierced by tunnels, valleys must be crossed on lofty embankments, or spanned by spacious aqueducts, and, above all, the whole must be conceived and laid out with scrupulous regard to the all-important object of securing the works against injury from an overflow of water during floods, and a consequent inundation of the surrounding country. Moreover, the necessity of laying out the canal in level stretches, and surmounting elevations by means of locks or inclined planes, occurring at intervals, often occasions much difficulty and greatly restricts the resources of the engineer. Taking, then, all these circumstances into consideration, and bearing in mind that canals were the pioneers of railways, we think it may safely be affirmed that the canal engineers of former days had more serious *physical* difficulties to contend with than are experienced in carrying out the railways of modern times, if we except such works as the Britannia Bridge, the high-level bridge of Newcastle, the Boxhill tunnel, and some other kindred works. But, indeed, their *mechanical* difficulties were also greater, for the introduction of steam, and its wide-spread application to all engineering operations, afford facilities to the engineers of the present day which Smeaton at the Eddystone, Stevenson at the Bell Rock, and Rennie and Telford in their early navigation works, did not enjoy. The distinguished merits of the engineers who practised in the former and at the commencement of the present century, cannot indeed be over-estimated, and had it been within the scope of this article it would have been profitable and instructive to have described in detail some of the grand aqueducts and other works on the lines of our canals. For this reference is made to the articles Aqueduct, Bridge, Tunnel, and Reservoir, all of which are more or less applicable to the formation of canals. We shall only therefore offer to the student the following summary of engineering principles generally applicable to all cases.

A canal cannot be properly worked without a supply of water calculated to last over the driest season of the year, and in that respect, except as to the quality of the water, demands all the care requisite in investigating the sources of water for supplying towns. If there be no *natural* lake in the district, available for supply and storage, the engineer must select situations suitable for artificial reservoirs, and the conditions to be attended to in selecting their positions are the same as those for water-works. They must command a sufficient area of drainage to supply the loss by leakage, evaporation, and lockage, due to the length of canal, number and size of the locks, and probable amount of traffic. The capability of the district to afford this supply will depend on the area of the basin drained and the annual amount of rainfall. The offlets from the reservoirs must be at such an elevation as to convey water to the summit-level of the canal. The embankments for retaining the water must be erected on sites affording a favourable foundation, and, if possible, in situations where an embankment of small height and length may dam up a large amount of water. It is further necessary to consider whether the subsoil of the valley forming the reservoirs is throughout of so retentive a nature as to prevent leakage, and it is essential to provide, by means of waste weirs, for the discharge of floods. The Caledonian Canal, to be afterwards noticed, is in this respect very favourably situated, the whole supply being obtained from natural lochs. In other cases, such as the Union, Forth and Clyde, Crinan, Birmingham, and other canals, it was necessary to construct large reservoirs in which the water is stored in winter and led in feeders to points convenient for supplying the canal in summer. Where the canal communicates with the sea or a tidal river, and where the natural supply is small, as at the Foss Dyke already referred to, the water is raised by pumping engines. It will readily be seen, therefore, how important it is to reduce to a *minimum* the loss of water due to leakage from deficient workmanship, as well as to lockage of the traffic through the canal, and (while on this subject) it may be stated that the *up* consumes a greater amount of water than the *down* traffic, for an *ascending* boat on entering a lock displaces a volume of water equal to its submerged capacity; the water so displaced flows into the lower reach of the canal and the lower gates are closed, the boat is then raised, and on passing into the higher reach of the canal its displacement lost on entering is supplied by water withdrawn from the higher reach. A *descending* boat, on the other hand, on entering a lock likewise displaces a volume of water equal to its submerged capacity, but the water in this case flows back into the higher reach of the canal, where it is retained when the gates are closed. Mr Fulton gives the consumption of 25-ton boats through locks of 8 feet lift as about 163 tons of water in ascending, and 103 in descending.[2] Several proposals have been made for reducing the loss of water by side ponds to receive part of the water, but all such plans delay the traffic and have not come into general use.

Sectional areas of barge canals.

The barge-canals constructed in this country are between 4 and 5 feet in depth. When the soil in which they were made was retentive, they were formed, as shown in the cross-section, fig. 1. But when the soil was porous, clay

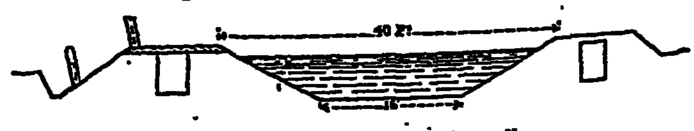


Fig. 1.—Section in retentive soil.

puddle was introduced, as shown in fig. 2. Professor Rankine says the depth of water and sectional area of water-way should be such as not to cause any material

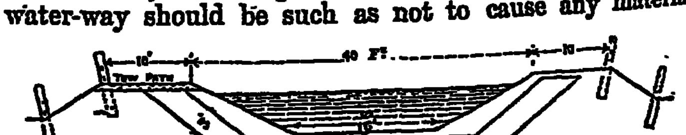


Fig. 2.—Section in porous soil.

increase of the resistance to the motion of the boats beyond what it would encounter in open water, and gives the following rules as fulfilling these conditions:—

Least breadth at bottom = 2 × greatest breadth of boat.
Least depth of water = $1\frac{1}{2}$ foot + greatest draught of boat.
Least area of water-way = 6 × greatest midship section of boat.

In laying out a line of canal the engineer is more restricted than in forming the route of a road or railway, where gradients can be introduced to suit the undulating surface of the country. A canal, on the contrary, must follow rigidly the bases of hills and windings of valleys, to preserve a uniform level, accommodation being made for the road traffic by erecting suitable "fixed" and "movable" bridges. It is important, as already stated, to lay out the work in long level reaches, and to overcome

[1] *Life of Telford*, London, 1838.

[2] Fulton's *Canal Navigation*.

elevations *in cumulo* by groups of locks at places where it can be most advantageously done. This leads to a saving of attendance and expense in working the canal, and causes fewer stoppages to the traffic. But to prevent waste of water the locks must be placed sufficiently far apart, say 100 yards, or an intervening pond or increased width of canal must be formed, so that a descending boat does not let off more water than the area below will receive without raising its surface so much as to lose the surplus water over the waste weirs. The mode of overcoming the difference of level between the various level reaches is, with few exceptions, by locks, which generally have a lift of 8 or 10 feet, though in some cases it is somewhat greater. The dimensions of the locks ought to be regulated by the traffic; but they should, in order to save water, be as nearly as possible the size of the craft to be passed through them, allowing from 6 inches to a foot of extra breadth and draught of water. The barge-canals in England have locks about 8 feet in breadth, and from 70 to 80 feet long, and their use in raising or lowering boats from the different reaches is so well known as not to require explanation; and for details as to the construction of the masonry of the chamber and walls, and the timber and iron work of the gates and sluices, reference is made to "Rankine's *Engineering*." The water is generally admitted into and flows from each lock by sluices formed in the gates, and the passage of a boat occupies from three to six minutes, depending on the lift. Sir William Cubitt, on the Severn navigation, introduced the water through a culvert parallel to the side wall of the lock, and opening in the centre by means of a tunnel, which admits of 16,000 cubic feet of water flowing into or out of the lock in $1\frac{1}{2}$ minute; and in little more than that time loaded vessels can be passed through.[1]

Inclined planes.

Inclined planes and perpendicular lifts, which have the advantage of saving water, were adopted so long ago as 1789 on the Ketling Canal in Shropshire, and afterwards on the duke of Bridgewater's canal. Mr Douglas of New York constructed the Morris Canal in the United States with 23 inclined planes, having gradients of about 1 in 10, with an average lift of 58 feet. The boats weighed, when loaded, 50 tons, and after being grounded on a carriage, were raised by water-power up the inclines with great ease and expedition. The length of the Morris Canal, between the rivers Hudson and Delaware, is 101 miles, and the whole rise and fall is 1557 feet, of which 223 were overcome by locks, and the remaining 1334 by inclined planes.[2] When first describing this work the author stated that the principal objection to the inclined planes for moving boats was the injury they were apt to sustain in supporting great weights while resting on the cradle. A slimly-built canal boat, 80 feet long, and loaded with 30 tons, could not be grounded on a smooth surface without straining her timbers, but this objection has to some extent been overcome on an inclined plane constructed by Mr Leslie and Mr Bateman on the Monkland Canal, where the boats are not wholly grounded on the carriage, but are transported in a caisson of boiler-plate containing 2 feet of water, and are thus *water-borne*. This inclined plane is wrought by two high-pressure steam-engines of 25 horse-power each. The height is 96 feet, and the gradient 1 in 10. The maximum weight raised is 80 tons, and the transit takes about ten minutes. The average number of boats passing over the incline is about 7500 per annum. Mr Green introduced on the Great Western Canal a perpendicular lift of 46 feet. Sir W. Cubitt also introduced three inclined planes, having gradients of 1 in 8, on the Chard Canal, Somersetshire.

Perpendicular lifts.

One of these inclines overcomes a rise of 86 feet; and they are said to act very satisfactorily.[3]

An essential adjunct to a canal is a sufficient number of waste-weirs to discharge surplus water accumulating during floods, which, if not provided with an exit, may overflow the tow-path, and cause a breach in the banks, stoppage of the traffic, and damage to adjoining lands. The number and positions of these waste-weirs must depend on the nature of the country through which the canal passes. Wherever the canal crosses a stream a waste-weir should be formed in the aqueduct; but independently of this the engineer must consider at what points large influxes of water may be apprehended, and must at such places not only form waste-weirs of sufficient size to carry off the surplus, but form artificial courses for its discharge into the nearest streams. These waste-weirs are placed at the top water-level of the canal, so that when a flood occurs the water flows over them and thus relieves the banks. The want of these has occasioned overflows of canal banks, attended with very serious injury to the works, and lengthened suspension of the traffic; and attention to this particular part of canal construction is of essential importance.

Stop-gates are necessary at short intervals of a few miles for the purpose of dividing the canal into isolated reaches, so that in the event of a breach the gates may be shut, and the discharge of water confined to the small reach intercepted between two of them, instead of extending throughout the whole line of canal. In broad canals these stop-gates may be formed like the gates of locks, two pairs of gates being made to shut in opposite directions. In small works they may be made of thick planks slipped into grooves formed at the narrow points of the canal under road bridges, or at contractions made at intermediate points to receive them. Self-acting stop-gates have been tried, but their success has not been such as to lead to their general introduction. When repairs have to be made stop-gates allow of the water being run off from a short reach, and afterwards restored with comparatively little interruption to the traffic. Their value in obviating serious accidents has been well exemplified in the author's own experience. The water during a flood flowed over the towing-path of the Union Canal connecting Edinburgh and Glasgow, and the uncontrolled current carried away the embankment and the soil on which it rested to the depth of 60 feet, as measured from the top water-level. The stop-gates were promptly applied, and the discharge confined to a short reach of a few miles, otherwise the injury (which was, even in its modified form, very considerable) would have been enormous, not only to the canal works but to the adjoining lands.

For the purpose of draining off the water to admit of repairs after the stop-gates have been closed, it is proper to introduce, at convenient situations, a series of exits called "offlets," which are pipes placed at the level of the bottom of the canal, and fitted with valves which can be opened when required. These offlets are generally formed at aqueducts or bridges crossing rivers, where the contents of the canal can be run off into the bed of the stream, the stop-gates on both sides being closed so as to isolate the part of the canal from which the water is withdrawn.

In executing the work, provision must be made for the proper drainage of the tow-path, which should be made highest at the side next the canal, and sloped with a gentle inclination towards the outside. The drainage of the tow-path should be carried to a sky drain, and at intervals passed below it into the canal, as shown in fig 3.

[1] *Minutes of Proceedings of Institution of Civil Engineers*, vol. v. p. 340.

[2] Stevenson's *Sketch of Civil Engineering in North America*, London, John Weale.

[3] *Minutes of Proceedings of Institution of Civil Engineers*, vol. [illegible] p. 205.

ching banks. The preservation of the banks at the water-line is also a matter of importance. "Pitching" with stones and "facing" with brushwood are employed, and in the author's experience the latter, if well executed, forms an economical and effectual protection.

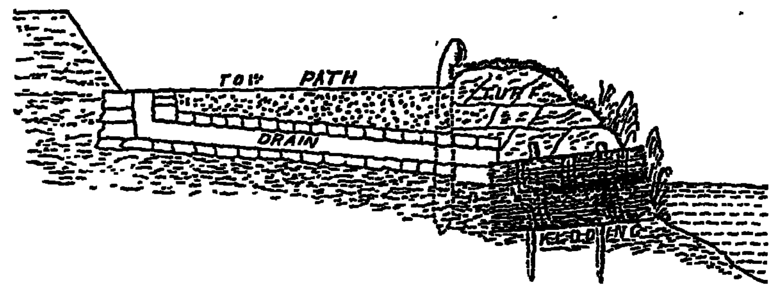


FIG. 3.—Showing Drainage of Tow-path.

ddling. In forming the *alveus* or bed of the canal care must be taken, especially on embankments, and even in cuttings where the soil is porous, to provide against leakage by using puddle, as shown as fig 2. An all-important matter, as affecting the construction of the works, is the possibility of getting clay in the district, or such other soil as may be worked into puddle, on the good quality of which the stability of the reservoir embankments and the imperviousness of the beds and banks of the canal mainly depend.

These are the only points of general application, in the construction of canals, to which reference can here be made; and in applying them to each case the engineer must be guided, *first*, by theoretical knowledge, to be acquired by a careful study of his profession; and, *secondly*, by that knowledge which can be gained only by experience.

le of lucting fic on ls. Not a little has been written on the best mode of conducting traffic on canals, and the reader who wishes to study the subject fully is referred to the observations made by Mr Walker and Mr George Rennie in the *Transactions* of the Royal Society and of the Institution of Civil Engineers, and especially to the valuable researches on hydrodynamics by Mr J. Scott Russell in the *Transactions* of the Royal Society of Edinburgh. Mr Russell while experimenting on propelling boats at high speeds found that the primary wave of displacement produced by the motion of a boat moves with a velocity due to the depth of water in the canal, being the velocity that is due to gravity acting through a height equal to the depth of the centre of gravity of the cross-section of the channel below the surface of the fluid. The velocity is in no degree dependent on the form or velocity of the body which generates it, or on the breadth of the canal. A wave that had a velocity of 8 miles an hour was traced to a point where the channel became deeper, and its velocity was suddenly accelerated; the channel became alternately narrower and wider without producing any sensible effect, but when the wave once more reached that part of the channel which was of the original depth it resumed its original velocity. A fact of great practical value was established, that a boat, if raised by a sudden effort to the top of a primary wave, could be drawn along at 10 miles an hour with less fatigue to the horses than if drawn at the rate of 6 miles, while the waste was less severe on the banks of the canal. These investigations were made before the general establishment of railways, when swift canal travelling seemed a desirable attainment. But though *boats* propelled at high speed on canals have given place to *railway carriages*, yet the canal traffic at slow speeds must be conducted, and the cheapest means of effecting the "haulage" with the least danger to the banks is still an important inquiry, and has within the last few years afforded matter for some highly interesting papers and statements in the *Proceedings* of the Institution of Civil Engineers. These are communications on the employment of steam-power on the Gloucester and Berkeley Canal, by G. W. B. Clegram;[1] on the Grand Canal, Ireland, by Mr Healy;[2] on the Forth and Clyde, by Mr J. Milne;[3] and on the Aire and Calder, by Mr W. H. Bartholomew,[4] to all which reference is made.

One great objection to high speeds on canals is the wasting of the banks by the displacement produced in propelling the vessel through the water. The wasting, indeed, takes place even with very low speeds, and as a matter of canal engineering it is necessary to notice it. To give an instance of the effect on the large scale:—Mr Ure says that the river steamers on the Clyde, going at a speed of 8 to 9 miles per hour, produce a swell which commences to rise when the vessel is "2 or 3 miles off,"—a circumstance which was first noticed by Mr J. Scott Russell in 1837. The swell gradually increases as the steamer approaches, and at last becoming a wave of translation, it breaks on the river walls nearly abreast of the vessel, following her on her course along the river, as a violent breaking wave, measuring 8 or 10 feet from the hollow in the channel to the crest on the wall. A coating of heavy whinstone rock, from 2 to 3 feet thick, extending from low to high watermark is found necessary to enable the banks to withstand it. Mr Ure also found that the action of passing steamers, though very destructive to the banks, was useful in stirring up the mud from the bottom, which was carried off by the currents to an extent which he estimates to be from 20 to 25 per cent. of the whole quantity dredged from one particular part of the river where he carefully measured it. It will at once be apparent, that however inconvenient these wasting waves may be in a river, the waves in a canal, though smaller, are nevertheless a source of greater anxiety, acting as they do in a narrow artificial channel, formed at some places on high embankments, the failure of which would be attended with serious consequences. Was the

The wasting on canals where the traffic is conducted at a moderate speed is found to extend not more than 18 inches to 2 feet, that is 1 foot above and below the water-line, and Mr Clegram states that he has found on the Gloucester Canal that a facing of stone filled into a recess cut in the banks formed a complete protection. Brushwood, as already noticed, is also an effectual remedy.

What has recently led to the consideration of the best means of protecting the banks of canals is the substitution of steam for horse power in working the traffic, which has been entirely successful. The first attempt at using steam-power on canals was made on the Forth and Clyde Canal with Symington's boat, in 1789. Various experiments were made to introduce tugs, but these were ultimately abandoned in favour of steam-lighters, which now in great numbers navigate the canal, and make passages to Leith, Greenock, and other trading ports on the Firths of Forth and Clyde. Steam-towing.

This system, however, would not suit the trade of the Gloucester Canal, which is chiefly frequented by sea-borne vessels, and steam-towing has been introduced on *that* navigation. The following extracts from Mr Clegram's paper[5] seem generally applicable to all navigations where towing is to be adopted. He says the ship canal leads from the Severn at Gloucester to the Severn at Sharpness Point. It is $16\frac{1}{2}$ miles in length, and has a depth varying from 18 to 18 feet 6 inches, navigable by vessels of 700 tons register. Prior to the year 1860 all sea-going vessels passing through were towed by horses, the number of horses being regulated by a scale varying from 1 horse for a vessel of 40 tons to 9 horses for a vessel of 420 tons. The cost of this amounted generally to about one farthing per ton per mile on the Steam-towing on Gloucester Canal.

[1] *Minutes of Proceedings of Institution of Civil Engineers*, vol. xxvi. p. 1. [2] *Ibid.*, p. 6. [3] *Ibid.*, p. 10.
[4] *Ibid.*, p. 25. [5] *Ibid.*, p. 1.

register tonnage of the vessel. The speed varied from one mile to three miles per hour, according to the size of the vessel and the state of the weather.

In 1860 steam-tugs were placed upon the canal to do this work. They are iron boats, 65 feet long, 12 feet beam, and draw 6 feet 3 inches of water, fitted with high-pressure engines; the diameters of the cylinders are 20 inches, stroke of 18 inches, pressure of the steam 32 ℔ on the inch, and the cost of each £3000. Nearly the whole of the sea-going craft are now towed by these tugs. The vessels range from 30 tons up to 700 tons register, with a draught of water from 6 to 16 feet. They are towed either singly or in a team, according to circumstances. Sometimes as many as thirteen loaded vessels of from 50 to 100 tons register have been towed by one tug at the rate of 3 to $3\frac{1}{2}$ miles an hour. The heaviest load drawn by any one tug has been 1690 tons of goods in three vessels. Their draught of water varied from 14 feet 6 inches to 15 feet 6 inches, and they were taken the whole length of the canal at the speed of 2 miles an hour. The smaller vessels are towed at a speed of 4 miles an hour, to which as a rule they are restricted.

The employment of steam for towing has been found very advantageous. The vessels rub less against the banks, the power being right ahead, and not on one side as with horses. The wear on the ropes used in tracking is reduced, the speed is increased, and vessels can be moved along the canal in weather which would have prevented horses doing the work. With a strong wind athwart the canal vessels cannot be tracked *in train;* they must then be taken singly, or at most two at a time. When vessels are towed in train, as a rule the largest and heaviest draughted are placed first, and the hawser leading from the first vessel to the tug is taken from each side of the bow. With this arrangement, and a skilful management of the tug, the vessels can be kept *fairly* in the line of the canal.

The only disadvantage of this system, on a canal the sides of which are unprotected, is the additional wear caused by the run of water between the sides of the large vessels and the banks. Such vessels occupy a large part of the sectional area of the canal, and being taken along at a much greater speed than they were by horses the wash of water is more prejudicial. When the vessels or trains of vessels are heavy, and the tugs are working up to their full power and speed, the water thrown back by the action of the screw against the bow of the first vessel is thrown off by it to the banks on either side, and is the cause of considerable wash. This has been attempted to be remedied by placing the first vessel farther back from the tug; but in practice it is found that a distance of 40 to 50 feet is the farthest separation that can be allowed without sacrificing that *hold* between the two which prevents the vessel sheering from side to side. The first vessel being kept steadily in her course, the others follow without much difficulty.

The employment of tugs has afforded an unexpected facility for cleansing the canal from deposit of mud. Formerly it was difficult to remove this deposit from the slopes of the banks on which it collected, sometimes inconveniently contracting the capacity of the canal. Since the vessels have been moved at greater speed and *in trains* this deposit has been entirely removed from the slopes to the bottom of the canal, whence it can readily be taken out by the dredger.

But though all efforts to improve barge-canals can never bring them to compete with railways in the quick conveyance of passengers, it is surprising to find in how many places they still command an enormous traffic in goods and minerals, and thus act as a valuable relief to overburdened railways. This is specially the case in the manufacturing districts of England, where the Birmingham Grand Junction and other canals seem to carry on as brisk a trade as they did in days gone by when they had no competitors but the stage coach and the carrier's van.

Ship canals

These remarks, however, as to railway competition do not apply to Ship-canals, which, undisturbed by competing schemes, retain all the monopoly they ever possessed; and indeed, in the recent construction of the Suez and New Amsterdam canals, they have acquired an importance before unclaimed for works of that class—an importance which entitles them to the highest consideration in any engineering treatise; for, apart from their structural interest to the engineer, their usefulness in affording a short and sheltered passage for sea-borne vessels has long been acknowledged and can hardly be over-estimated.

The Languedoc Canal already mentioned, by a short passage of 148 miles, saves a sea voyage of upwards of 2000 miles through the Straits of Gibraltar. By the Forth and Clyde Canal sea-borne vessels, not exceeding $8\frac{1}{2}$ feet draught of water, can pass from opposite coasts of Scotland, through the heart of the country, by 35 miles of inland navigation and avoid the dangers of the Pentland Firth; the Crinan Canal substitutes a short inland route of 9 miles for a sea voyage round the Mull of Kintyre of about 70 miles; and the last great canal between Suez and the Mediterranean effects a saving of 3750 miles on the route to India.

To most of the early ship canals that have been executed, the principles of construction already stated are generally applicable—the depth of water and dimensions of the locks and all other works being increased to suit the larger size of craft which use them, and therefore further notice of such details is not required. But having still to illustrate the larger class of works, we proceed to describe some of the largest of the ship-canals already constructed and projected, and in doing so, we shall consider ship-canals under the following three classes :—

Th... clas... ship

First, Canals which on their route from sea to sea traverse high districts, surmounting the elevation by locks supplied by natural lakes or artificial reservoirs, such as the Languedoc in France, or the Caledonian Canal in Scotland;

Second, Canals in low-lying districts, which are carried on a uniform water-level from end to end, and are defended against the inroad of the sea at high water by double acting locks, which also retain the canal water at low tide, such as the canals of Holland and other low countries;

Third, Canals, of which the Suez is the only example yet made, without locks at either end, and communicating freely with the sea, from which it derives its water supply.

Ca... C...

The Caledonian Canal in Scotland is as good a specimen of works of the *first* class as can be selected.

In 1773 James Watt was employed to survey the country between the Beauly at Inverness and Loch Eil at the mouth of the river Lochy, a distance of about 60 miles, with the view of forming a ship canal between the two seas, to save about 400 miles of coasting voyage by the North of Scotland through the stormy Pentland Firth. The district referred to, called the "Great Caledonian Glen," as will be seen from Plate XXXVI., embraces a chain of fresh-water lakes, which, in connection with the surrounding glens, have afforded an interesting field for the speculations of the geologist; and no doubt the first conception of a canal through the district owed its origin to the apparent facilities for inland navigation which the lakes afforded.[1] In 1801 Telford was employed by Government to report, and the ultimate result of that report was the construction of the canal.

The district which discharges into the eastern outlet comprehends an area of about 700 square miles, chiefly of high mountainous country, intersected by streams and lakes, which discharge themselves into Loch Oich, Loch Ness, and Loch Doughfour, and thence are conveyed into the Moray Firth by the River Ness. Loch Oich, the summit-level of the canal, has an area of about 2 square miles, and the present standard level of its surface is understood to be 102 feet above the level of mean high water of neap tides in Beauly Firth. It receives the drainage of Loch Quoich and Loch Garry. The waters of Loch Oich are discharged through the River Oich into Loch Ness, which is about 24 miles in length, and has an area of about 30 square miles. Loch Ness receives the waters of the Tarff, the Foyers, and Glenmoriston, and the drainage of numerous other streams and lakes of less note. It discharges its waters through a comparatively narrow neck, called Bona Passage, into the small loch of Doughfour, whence they find an exit to the Beauly and Moray Firths by the River Ness, on which the town and harbour of Inverness are situated.

The drainage of the western district of the country, including Loch Arkegg, finds its way into Loch Lochy, which is about 10 miles long, and thence by the River Lochy to the Western Sea at Loch Eil.

The two locks in Loch Beauly at the northern entrance to the canal are each 170 feet long, 40 feet wide, and have a *lift* of about 8 feet. At Muirtown, a little further on, are four locks of 170 feet in length and 40 feet in width, having a rise of 32 feet, raising the canal to the level of Loch Ness, which it enters at Bona. The works westward of Loch Ness are an artificial canal with seven locks communicating with Loch Oich. Between Lochs Oich and Lochy are two locks; at the south end of Loch Lochy is a regulating lock, and the canal is carried from this point on the level of Loch Lochy to Banavie, where it descends 64 feet by eight connected locks, forming what is called in the country "Neptune's Staircase;" finally at Corpach the canal descends by two locks to the level of Loch Eil.

Of the whole distance, about $37\frac{1}{2}$ miles are natural lake navigation, and the remaining 23 are artificial or canal navigation. The canals were made 120 feet in width at top-water level, 50 feet at bottom, and 20 feet in depth. In the course of inquiries as to the state of the canal, under a remit from the Admiralty, the author found that the shallows at Loch Oich and the cutting at the summit level originally contemplated had not been carried to the full depth, and an additional depth had been gained at that place by raising the level of Loch Oich; but still he was led to the conclusion that the standard depth of the canal cannot be regarded as more than 18 feet, giving access to vessels of 160 feet in length, 38 feet beam, and 17 feet draught of water.[1]

In carrying out this remarkable work Telford had to deal with difficulties of no ordinary kind, in rendering available rugged Highland lakes, and surmounting the summit-level of the glen. The work, which cost about one million sterling, is a noble monument of his engineering skill.

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ud.

The canals of Holland are specimens of the *second* class of works to which reference has been made, and of these a very remarkable one is the North Holland Canal, completed in 1825. It was designed by M. Blanken, who, instead of the high rugged Highland glens of Scotland, had to deal with the proverbial lowness of the country, and to protect his works not from the assaults of mountain torrents but from encroachments of the waves, for there vessels are locked *down* from the sea into the canal. It extends from Amsterdam to the Helder, is 50 miles in length, and is formed of the cross-section shown in fig. 4. It enables vessels trading from Amsterdam to avoid the islands and sand-banks of the dangerous Zuider-Zee, the passage through which in former times often occupied as many weeks as the transit through the canal now occupies hours.

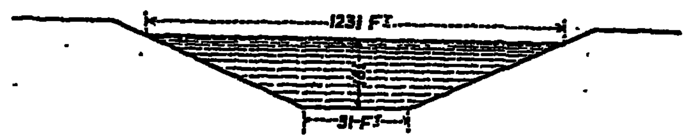


FIG. 4.—Cross-section of North Holland Canal.

But the North Holland Canal, which has long proved so useful to the commerce of the district, is destined soon to be superseded by the new Amsterdam Canal, a work of great magnitude, which it is proposed to describe as an illustration of ship-canals of the *second* class from details furnished by Mr J. C. Hawkshaw, C.E. Amsterdam Canal

The rapid increase in the trade of the ports to the southward and eastward of the Helder, effected by the construction of railways throughout Europe, rendered it imperative for the merchants of Amsterdam to provide better communication with the North Sea than that afforded by the North Holland ship canal already noticed, or suffer its trade to pass to other ports more favourably situated for over-sea traffic.

In 1865 a company was formed for the purpose of constructing a canal from Amsterdam, in nearly a direct line, to the North Sea, through Lake Y and Wyker Meer, a distance of $16\frac{1}{2}$ miles. Sir John Hawkshaw and Mr Dirks were appointed the engineers to carry out the work, a plan and section of which are given in Plate XXXVI.

The harbour in which the canal terminates in the North Sea is formed by two piers built of concrete blocks founded on a deposit of rough basalt. The piers are each 5069 feet in length, and enclose an area of about 260 acres. About 140 acres of this area are to be dredged to a depth of $26\frac{1}{4}$ feet, the remainder is to be left at the present depth for the accommodation of small craft and fishing-boats.

From its commencement at the harbour the canal passes by a deep cutting through a broad belt of sand-hills which protect the whole of this part of the coast of Holland from the inroads of the sea. The cross-section of the canal at this place is shown in fig. 5. This cutting is about 3 miles

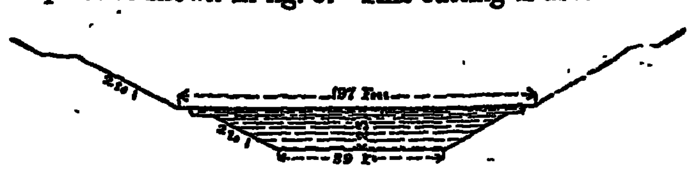


FIG. 5.—Cross-section of Amsterdam Canal.

in length; the greatest depth of cutting from the surface to the bottom of the canal is 78 feet, and the amount of earthwork excavated is 6,213,000 cubic yards. On emerging from the sand-hills the canal passes by the village of Velsen, in the neighbourhood of which it is crossed by the railway from Haarlem to the Helder, and there enters the Wyker Meer, a large tract of tide-covered land. After traversing the Wyker Meer it passes by a cutting of 327,000 cubic yards through the promontory called Buitenhuizen, which separates that Meer from Lake Y, another large tide-covered area. The rest of its course lies through Lake Y as far as Amsterdam.

There are two sets of locks, one set at each end. The North Sea locks are at a distance of about three-quarters of a mile from the North Sea harbour. These locks, as shown in fig. 6, have three passages. The central or main one is 60 feet wide and 390 feet long, and will be furnished with two pairs of gates at each end, pointing in opposite direc-

[1] *Report on the Caledonian Canal to the Admiralty*, 1849, by James Veitch, R.E., and David Stevenson, C.E.

tions, and one pair in the centre. The northernmost side passage for barges is 30 feet long and 34 feet wide, with three pairs of gates; that to the south is 227 feet in length and 40 feet wide, with five pairs of gates.

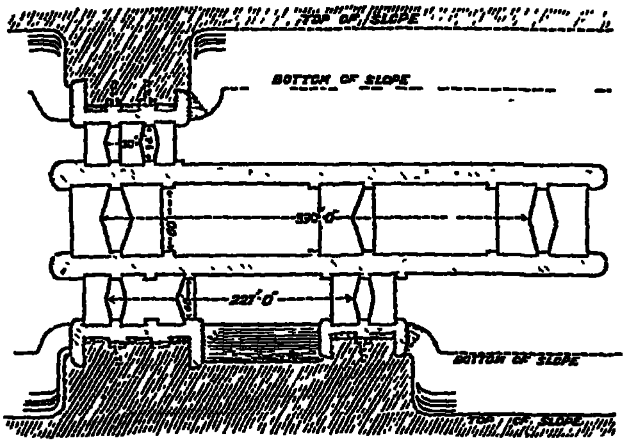


FIG. 6.—Plan of Locks on Amsterdam Canal.

In constructing the canal, which is (1876) now far advanced towards completion, the cuttings were first begun. The material proceeding from these cuttings was deposited so as to form two banks 443 feet apart, through the lakes on each side of the main canal, as shown by the hard lines on the plan, and also to form the banks of the branch canals on either side. The total length of these banks is 38½ miles. The nucleus of the bank is formed of sand with a coating of clay, and protected during its progress with fascines; and when the banks are far enough advanced, the deep channel for the canal is excavated by dredging. The cross-section of the canal and banks through these meers or lakes is shown in fig. 7.

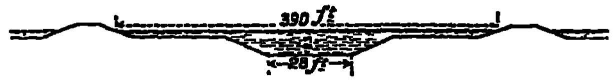


Fig. 7.

The formation of the banks through the Wyker Meer and Lake Y will enable about 12,000 acres of the area, as shown on the plan, which is now occupied by these lakes, to be reclaimed. For the purpose of this reclamation, and also to provide for the drainage of the land on the margin of the lakes, including a large portion of what was formerly Haarlem Meer, pumps are provided by the company at various points on the main and branch canals. The Canal Company are bound to keep the surface-water of the canal about 1 foot 7 inches *below* average high-water level. In order to insure this level being maintained, three large pumps have been erected in connection with the locks hereafter to be described, on the dam between Amsterdam and the Zuider Zee. They consist of three Appold pumps, the largest of the kind yet made, the fans being 8 feet in diameter. Each pump is worked by a separate engine of 90 nominal horse-power. The maximum lift is 9 feet 9 inches, at which the three pumps are capable of discharging 1950 tons a minute; with the ordinary working lift of 3½ feet they will discharge 2700 tons a minute.

Lake Y extends about 4½ miles to the eastward of Amsterdam; and here it was necessary to form a dam with locks for the passage of vessels. The dam crosses Lake Y at a point about 2 miles to the eastward of Amsterdam, where it is contracted to 4265 feet in width. As it was necessary to construct these locks before completing the dam across Lake Y, a circular cofferdam 590 feet in diameter, consisting of two rows of piles 49 feet long, was constructed in the tideway, and within this dam the locks were built. These locks have three main passages, each with five pairs of gates, and one smaller passage with three pairs of gates, arranged much in the same manner as the North Sea locks in fig. 6. The whole of the masonry and brickwork for these locks and sluiceways was founded on bearing-piles, upwards of 10,000 in number. The bottom where the cofferdam was placed consisted of mud, and some difficulty was experienced in maintaining it till the work was completed. The dam across Lake Y, as shown in section, fig. 8, consists of clay and sand, placed on and

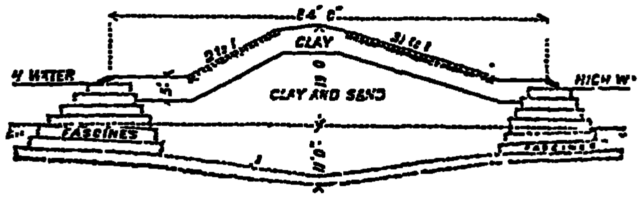


FIG. 8.—Section of Dam across Lake Y.

protected at the sides by large masses of wicker-work, which is afterwards covered with basalt in the manner usually adopted in Holland.

All the lock gates at both ends of the canal pointing seawards are of malleable iron; the gates pointing inwards towards the canal are of wood. The necessity, for drainage purposes, of maintaining the surface water of the canal at the prescribed low level calls for a sufficient barrier being provided against the sea at both ends, as the sea-level will not unfrequently, at high water, be several feet above the level of the canal. This necessity, as well as the difference of level and periods of high water in the Zuider Zee and the North Sea, required a totally different design from the Suez Canal, to be afterwards described. The contract sum for the execution of the Amsterdam Canal is £2,250,000, and it is expected that it will be ready for traffic in 1877.

Of the *third* class of works there is, as yet, only a single example in the Suez Canal, one of the most remarkable engineering works of modern times; but though it is called a canal, it bears little resemblance to the works we have described under that name, for it has neither locks, gates, reservoirs, or pumping engines, nor has it, indeed, anything in common with canals, except that it affords a short route for sea-borne ships. It is in fact, correctly speaking, an artificial strait or arm of the sea, connecting the Mediterranean and the Red Sea, from both of which it derives its water-supply; and the fact that the two seas are nearly on the same level, and the rise of tide very small, allowed this construction to be adopted.

The idea of forming this connecting link between sea and sea is of very ancient origin, and its author is unknown. It is understood, however, that a water communication for small vessels between the two seas was formed as early as 600 years before the Christian era, and existed for a period of about 1400 years, after which it was allowed to fall into disuse. Baron De Tott in his *Memoirs of the Turks and Tartars*,[1] written in 1785, after giving quotations from the historian Diodorus as to the existence of certain portions of the early work, and its having been abandoned in consequence of the supposed difference of level between the two seas, and threatened inundation of Egypt, says there still exist those early traces of work "qu'un léger travail rendrait navigable sans y employer d'écluses et sans menacer l'Égypte d'inondations." De Tott's opinion expressed in 1785 has certainly been carried out, but on a scale and at an expenditure of labour and money far beyond the conception of the French diplomatist.

The idea of restoring this ancient communication on a

[1] *Mémoires du Baron de Tott, sur les Turcs et les Tartares*, Amsterdam, 1785, vol. ii. p. 271.

scale suited to modern times is understood to be due to Napoleon I. who, about the close of the last century, obtained a report from M. Lepère, a French engineer, which however was followed by no result, and it remained for M. de Lesseps, in the present day, to realize what were thought the dreams of commercial speculators, by carrying out the long-desired passage between the two seas. But the postponement of the scheme unquestionably favoured the chances of its commercial success, for had the canal been completed even a few years earlier, comparatively few vessels would have been found to take advantage of it. Masters of sailing-vessels would not from choice have navigated the Mediterranean and encountered the passage through the canal and the tedious and difficult voyage of the Red Sea. They would undoubtedly have preferred to round the free seaway of the Cape of Good Hope, with all its ocean dangers and excitements, to threading their way through such an inland passage, involving risks of rocks and shoals, protracted calms and contrary winds. But the introduction of ocean-going screw-steamers was an entirely new feature in navigation. Being independent of wind for their propulsion, and being admirably fitted for navigating narrow straits and passages, their rapid and general adoption by all the leading shipping firms in the world afforded not only a plea, but a necessity for the short communication by the Mediterranean and Red Sea. It was indeed a great achievement to reduce the distance between Western Europe and India from 11,379 to 7628 miles, equal, according to Admiral Richards and Colonel Clarke, R.E., to a saving of thirty-six days on the voyage; and this is the great result effected by cutting the Suez Canal between the Mediterranean and the Red Sea.

Mr Bateman, C.E., who visited the canal as the representative of the Royal Society, communicated to that body a description of the works, in which he gives the following account of the early negotiations of M. Ferdinand Lesseps, who has the credit of having brought the work to a successful issue:[1]—

"The project" of M. Ferdinand Lesseps "was to cut a great canal on the level of the two seas, by the nearest and most practicable route, which lay along the valley or depression containing Lake Menzaleh, Lake Ballah, Lake Timsah, and the Bitter Lakes. The character of this route was described in 1830 by General Chesney, R.A., who examined and drew up a report on the country between the Mediterranean and the Red Sea. At that time a difference of 30 feet between the two seas was still assumed, and all proposals for canals were laid out on that assumption. General Chesney summed up his report by stating, —'As to the executive part there is but one opinion; there are no serious difficulties; not a single mountain intervenes, scarcely what deserves to be called a hillock; and in a country where labour can be had without limit, and at a rate infinitely below that of any other part of the world, the expense would be a moderate one for a single nation, and scarcely worth dividing among the great kingdoms of Europe, who would all be benefited by the measure.'

"M. Lesseps was well advised therefore in the route he selected, and (assuming the possibility of keeping open the canal) in the character of the project he proposed.

"From 1849 to 1854 he was occupied in maturing his project. In the latter year Mahomet Saïd Pasha became Viceroy of Egypt, and sent at once for M. Lesseps to consider with him the propriety of carrying out the work. The result of this interview was, that on the 30th of November a commission was signed at Cairo, charging M. Lesseps to constitute a company named 'The Universal Suez Canal Company.' In the following year, 1855, M. Lesseps, acting for the Viceroy, invited a number of gentlemen, eminent as directors of public works, as engineers, and distinguished in other ways, to form an International Commission for the purpose of considering and reporting on the practicability of the scheme.

"The Commission met in Egypt in December 1855 and January 1856, and made a careful examination of the harbours in the two seas, and of the intervening desert, and arrived at the conclusion that a ship canal was practicable between the Gulf of Pelusium in the Mediterranean and the Red Sea near Suez. They differed, however, as to the mode in which such a canal should be constructed. The three English engineering members of the Commission were of opinion that a ship canal, having its surface raised 25 feet *above* the sea-level, and communicating with the Bay of Pelusium at one end and the Red Sea at the other, by means of locks, and supplied with water from the Nile, was the best mode of construction. The foreign members, on the contrary, held that a canal having its bottom 27 feet *below* sea-level, from sea to sea, without any lock, and with harbours at each end, was the best system,—the harbours to be formed by piers and dredging out to deep water.

"The Commission met at Paris in June 1856, when the views of the English engineers were rejected, and the report to the Viceroy recommended the system which has since been carried out....

"Two years from the date of this report were spent in conferences and preliminary steps before M. Lesseps obtained the necessary funds for carrying out the works. About half the capital was subscribed on the Continent by far the larger portion being taken in France, and the other half was found by the Viceroy. Further time was necessarily lost in preparation, and it was not till near the close of 1860 that the work was actually commenced.

"The original concession granted extraordinary privileges to the Company. It included or contemplated the formation of a 'sweet water' canal for the use of the workmen engaged, and the Company were to become proprietors of all the land which could be irrigated by means of this canal. One of the conditions of the concession also was that the Viceroy should procure forced labour for the execution of the work, and soon after the commencement of operations, and for some time, the number of workmen so engaged amounted to from 25,000 to 30,000. The work thus commenced steadily proceeded until 1862, when the late Viceroy, during his visit to this country at the time of the International Exhibition, requested Sir John Hawkshaw to visit the canal and report on the condition of the works and the practicability of its being successfully completed and maintained. His Highness's instructions were that Sir John Hawkshaw should make an examination of the works quite independently of the French company and their engineers, and report the results at which he arrived."

We quote these results as given in Sir John Hawkshaw's report, because they show the nature of the difficulties that had been raised and the soundness of the advice which Sir John gave—advice which undoubtedly greatly contributed to the successful completion of the work.

The following are given by Sir John as the *objections to* the work:—

"1. That the canal will become a stagnant ditch.

"2. That the canal will silt up, or that the moving sands of the Desert will fill it up.

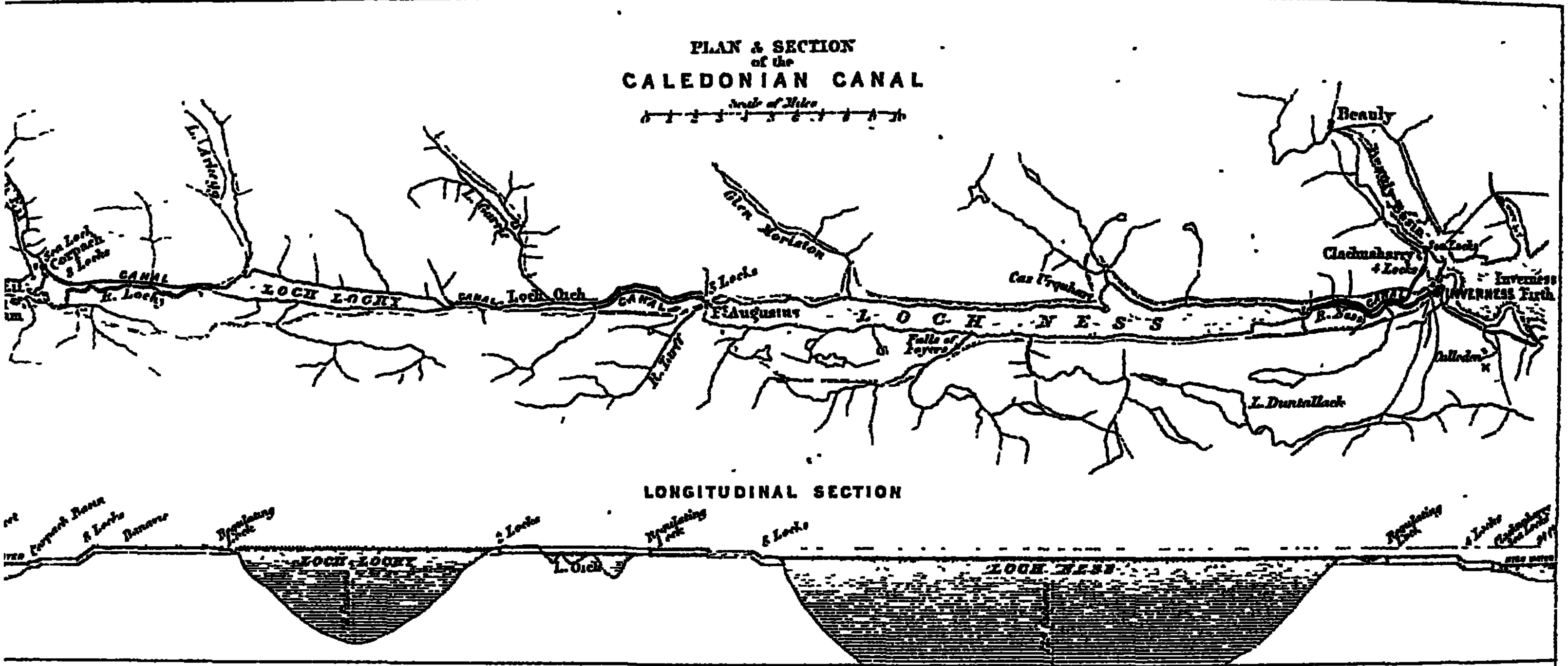
"3. That the Bitter Lakes through which the canal is to pass will be filled up with salt.

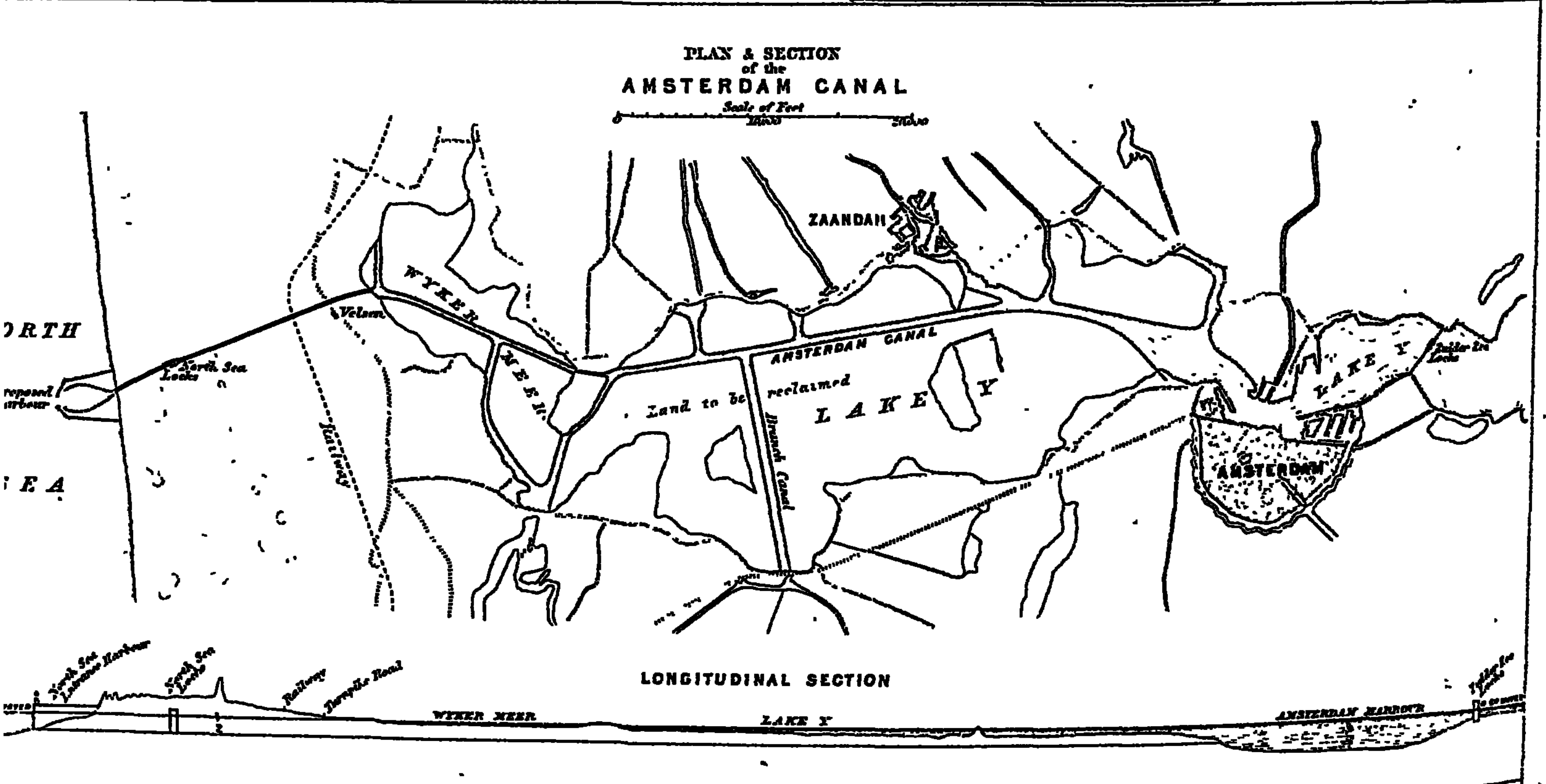
"4. That the navigation of the Red Sea is dangerous and difficult.

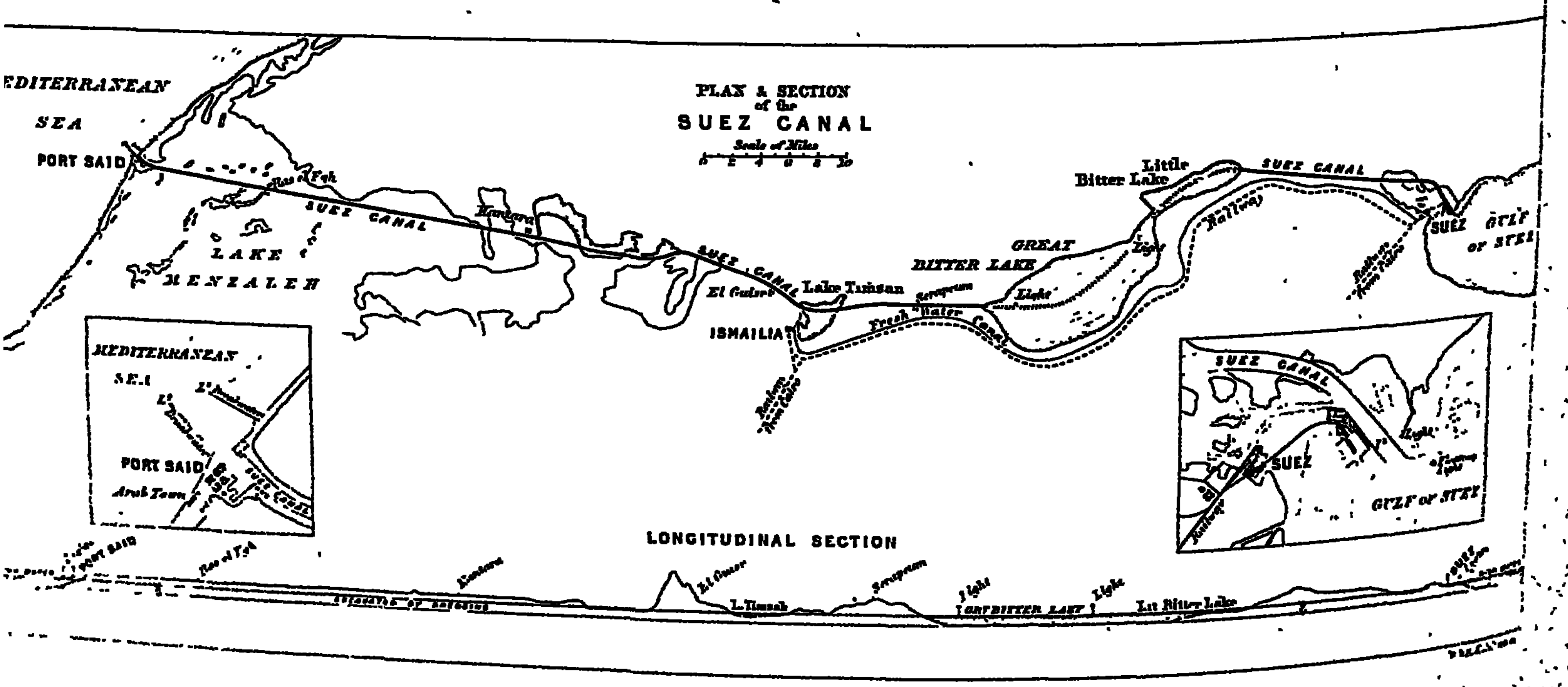
"5. That shipping will not approach Port Saïd, because of the difficulties that will be met with, and the danger of that port on a lee shore.

"6. That it will be difficult, if not impracticable, to keep open the Mediterranean entrance to the canal."

[1] *Proceedings of the Royal Society*, 1870, p. 132.


PLAN & SECTION of the
CALEDONIAN CANAL
Scale of Miles
Beauly
Clachnaharry
Inverness
INVERNESS Firth
Culloden
L. Duntallach
Falls of Foyers
Ft. Augustus
Loch Oich
LOCH LOCHY
CANAL
LOCH NESS
Glen Moriston
L. Arkaig
LONGITUDINAL SECTION
Regulating Lock
LOCH LOCHY
L. Oich
LOCH NESS


PLAN & SECTION of the
AMSTERDAM CANAL
Scale of Feet
ZAANDAM
WYKER MEER
Velsen
North Sea Locks
AMSTERDAM CANAL
Land to be reclaimed
LAKE Y
Branch Canal
Railway
AMSTERDAM
LONGITUDINAL SECTION
WYKER MEER
LAKE Y
AMSTERDAM HARBOUR


MEDITERRANEAN SEA
PORT SAID
LAKE MENZALEH
SUEZ CANAL
PLAN & SECTION of the
SUEZ CANAL
Scale of Miles
Little Bitter Lake
GREAT BITTER LAKE
Railway
SUEZ
Lake Timsah
El Guisr
ISMAILIA
Fresh Water Canal
MEDITERRANEAN SEA
PORT SAID
Arab Town
SUEZ CANAL
SUEZ
GULF OF SUEZ
LONGITUDINAL SECTION
PORT SAID
El Guisr
L. Timsah
Serapeum
Lit. Bitter Lake

Having analysed each of these objections, and fully weighed the arguments on which they were based, he came to the following conclusions as to the practicability of construction and maintenance:—

"*1st*, As regards the engineering construction, there are no works on the canal presenting on their face any unusual difficulty of execution, and there are no contingencies that I can conceive likely to arise that would introduce difficulties insurmountable by engineering skill.

"*2dly*, As regards the maintenance of the canal, I am of opinion that no obstacles would be met with that would prevent the work, when completed, being maintained with ease and efficiency, and without the necessity of incurring any extraordinary or unusual yearly expenditure."

"Saïd Pasha died between the period of Sir John Hawkshaw's examination of the country and the date of his report. He was succeeded by his brother, Ismail, the present Viceroy or Khedive, who, alarmed at the largeness and uncertainty of the grants to the Canal Company, of the proprietorship of land which could be irrigated by the sweet water canal, and anxious to retire from the obligation of finding forced labour for the construction of the works, refused to ratify or agree to the concessions granted by his brother. The whole question was then referred to the arbitration of the late Emperor of the French, who kindly undertook the task, and awarded the sum of £3,800,000 to be paid by the Viceroy to the Canal Company as indemnification for the loss they would sustain by the withdrawal of forced or native labour, for the retrocession of large grants of land, and for the abandonment of other privileges attached to the original act of concession. This money was applied to the prosecution of the works.

"The withdrawal of native labour involved very important changes in the mode of conducting the works, and occasioned at the time considerable delay. Mechanical appliances for the removal of the material, and European skilled labour, had to be substituted; these had to be recruited from different parts of Europe, and great difficulty was experienced in procuring them. The accessory canals had to be widened for the conveyance of larger dredging-machines, and additional dwellings had to be provided for the accommodation of European labourers. Ultimately all difficulties were overcome, and the work proceeded."

After the works had been nearly completed, the Lords of the Admiralty instructed Admiral Richards, the hydrographer, and Lieutenant-Colonel Clarke, R.E., to visit Egypt, and report as to the condition of the canal. These officers accordingly made a most minute survey of the canal and its terminal harbours, and issued a most interesting report,[1] from the information contained in which the plan of the canal, Plate XXXVI., has been mainly constructed. From this plan it will be seen that the canal extends from Port Saïd on the Mediterranean to Suez on the Red Sea, and that, as shown by the section, it traverses a comparatively flat country. This route has been selected so as to take advantage of certain valleys or depressions which are called lakes, but were in fact, previous to the construction of the canal, low-lying tracts of country, at some places below the level of the Mediterranean and Red Seas. These valleys were found to be coated with a deep deposit of salt, and are described as having had all the appearance of being covered with snow, bearing evidence of their having been at one period overflowed by the sea. As will be seen from the plan, Lake Menzaleh is next to the Mediterranean, Lake Timsah about half-way across the isthmus, and the Bitter Lakes next to the Red Sea. Lake Timsah, which is about 5 miles long, and the Bitter Lakes, about 23, were quite dry before the cutting of the canal, and the water which has converted them into large inland lakes was supplied from the Red Sea and Mediterranean. The water began to flow from the Mediterranean in February 1869, and from the Red Sea in July, and by the beginning of October of the same year these vast tracts of country, which had formerly been parched and arid valleys, were converted into great lakes navigated by vessels of the largest class. It will be seen from the section that the surface of the ground is generally very low, the chief cuttings being at Serapeum and El Guisr, where the sandy dunes attain an elevation of about 50 to 60 feet. The channel through the lakes was excavated partly by hand labour and partly by dredging, and for a considerable portion the level of the valleys was so low as to afford sufficient depth without excavation. The material excavated appears to have been almost entirely alluvial, and easily removed; the only rock was met with at El Guisr, where soft gypsum occurred, removable to a considerable extent by dredging, so that the canal works presented no physical difficulty.

The whole length of the navigation is 88 geographical miles. Of this distance 66 miles are actual canal, formed by cuttings, 14 miles are made by dredging through the lakes, and 8 miles required no works, the natural depth being equal to that of the canal. Throughout its whole length the canal was intended to have a navigable depth of 26 feet for a width of 72 feet at the bottom, and to have a width at the top varying according to the character of the cuttings. At those places where the cuttings are deep, the slopes were designed to be 2 to 1, with a surface width at the water-line of about 197 feet, as shown in fig. 9, which

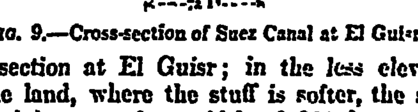


Fig. 9.—Cross-section of Suez Canal at El Guisr.

is a cross-section at El Guisr; in the less elevated portions of the land, where the stuff is softer, the slopes are increased, giving a surface width of 325 feet. It will be understood that in the lakes the canal consists of a navigable channel of sufficient depth and breadth to admit the traffic, the surface of the water extending on either side to the edge of the lake. Fig. 10 shows a cross-section at Lake

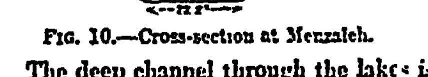


Fig. 10.—Cross-section at Menzaleh.

Menzaleh. The deep channel through the lakes is marked by iron beacons on either side, 250 feet apart, and the Admiralty reporters state that "in practice it is found more difficult to keep in the centre while passing through these beacons, than it is when between the embankments." At every 5 or 6 miles there is a passing-place, to enable large vessels to moor for the night, or to bring-up in order to allow others to pass, all these movements being regulated by telegraph from Port Saïd, Ismailia, or Suez. Perhaps the most interesting question to the engineer is the action of the tide in the narrow channel between the two seas, and the observations made on this subject are given in the following quotation from the Admiralty report:—

[1] *Report on the Maritime Canal connecting the Mediterranean at Port Saïd with the Red Sea at Suez*, February 1870.

filled from the Mediterranean in April 1867, has risen 12 centimetres, or about 4 inches, and that its waters are continually running at a slow rate into the Mediterranean; certainly this statement agreed with what we ourselves remarked, for we always found a current running northward from Lake Timsah at the rate of from half a mile to a mile an hour. Limited, however, as these tidal observations were, they were taken with great care, and appear sufficient to show that, except at the Suez end, the tides will not materially affect the passage of vessels; at that end, therefore, large vessels must regulate their time of passing; indeed, the greatest difficulty which will be experienced will be not from the tides, but from the prevailing north-east wind in the canal, which will make close steerage difficult in going from north to south."

It thus appears that the tidal column of 5 feet range in the Red Sea is reduced to 2 feet at the distance of 6 miles, and is practically annihilated by the wide expanse of the Bitter Lakes. But it would be highly interesting to have this conclusion confirmed by further systematic tidal observations.

In executing this strange work of the desert, and converting dry sands into navigable lakes, it is stated that there have been about *eighty millions* of cubic yards of material excavated, and at one time sixty dredging-machines and nearly 30,000 labourers were employed. For their use a supply of fresh water was conveyed from the Nile at Cairo, and distributed along the whole length of the canal, a work which of itself was one of no small magnitude.

The cost of the whole undertaking, including the harbours, is stated to have been about £20,000,000. The terminal harbours are important adjuncts of this great work. That on the Mediterranean is Port Saïd, which is formed by two breakwaters constructed of concrete blocks, the western one 6940 feet in length and the eastern 6020 feet, enclosing an area of about 450 acres, with an average depth of only 13 or 14 feet, excepting in the channel leading to the canal, where the depth is 25 to 28 feet. The entrance to the canal at Suez is also protected by a breakwater, and in connection with the harbour at this place there are two large basins and a dry dock.

The canal may be regarded as a highway for steamers of 400 feet in length and 50 feet beam. A delay of three days is calculated on for the passage across from Port Saïd to Suez.

It is satisfactory to learn from the report of Commander Wharton, of H.M.S. "Shearwater," "that the canal retains its depth of water. That report states that "comparing generally the depth of the canal in 1873 and 1875 it seems that it is in about the same condition, with perhaps a slight balance in favour of increased depth now; while its average minimum may be stated at 26 feet, there are yet considerable tracts where 25 feet and even as little as 24 feet will be passed over." The survey of Lieutenant Millard, also reported to the Admiralty in 1875, shows that at the entrance to Port Saïd harbour the 27, 30, and 33 feet contour lines were seaward of those obtained before, proving that some shallowing of the water at the entrance has taken place.

The use made of the canal may be judged of from the following table of the traffic passing through since its commencement[1]:—

Year.	Number of Vessels.	Gross Tonnage.	Receipts.
1870	486	654,915	£206,373
1871	765	1,142,200	359,748
1872	1082	1,744,481	656,303
1873	1173	2,085,072	915,892
1874	1264	2,423,672	994,375

The tonnage has thus been quadrupled in five years; and the best means of enlarging the canal to accommodate increasing trade must soon become an important question for its owners.

Such works as the ship canals we have been describing entirely revolutionize ocean navigation, and consequently demand the zealous attention of all nations whose interests they seem to affect. Of this zealous watchfulness the interest taken by the Powers of Europe in the distribution of the property in the Suez Canal may be cited as an example. But notwithstanding the difficulties, legal and political, which the execution of such works are almost sure to create by severing continents before united, and connecting seas before separated by thousands of miles of exposed navigation, we may safely conclude that wherever the perils and delays of ocean sailing can be lessened by forming canals these valuable helps to navigation will at all hazards be carried out. Viewing then the subject *prospectively*, we offer no apology for noticing two important short sea passages which, though still unexecuted, will doubtless in some form be eventually carried out.

Proposed Paumben canal.

One of these canals is designed to obviate the navigation of the dangerous strait between Ceylon and the mainland of India, which is shallow and narrow, and in some states of the wind has a violent current, so that it can only be navigated by vessels of small draught. Ships of the larger class have to circumnavigate Ceylon in making their passages to the eastern section of Hindustan. The importance of avoiding this detour round Ceylon of 350 miles of exposed navigation in the direct Suez route to Calcutta and Madras will be readily acknowledged, and the execution of the work cannot long be delayed.

The strait to which we allude is the Paumben passage leading from the Gulf of Manaar on the west to Palk Bay on the east, as shown in fig. 11, and many attempts have been made by blasting to clear away the rocky obstructions that at present render its navigation dangerous. But in order to provide a safe passage of the strait between Ceylon and India for the ships which now navigate the Suez Canal, nothing will suffice but a canal affording the same depth and width, though very much shorter in length than its great pioneer in shortening ocean sailing; and accordingly surveys have been made and schemes have been proposed to effect this important improvement. Mr George Robertson, Civil Engineer, when inspecting the harbours of India, was asked by the British Government to visit the locality and report on these schemes; and from his Report on Indian Harbours we find that the site he selected as most suitable is through the island of Ramaseram, about a mile east from Paumben lighthouse. The distance across from sea to sea is about 2 miles, the ground being a flat sandy plain, raised on an average about 7 feet above high water, and from the borings that have been made it is not expected that much rock will be found in the course of the canal. In order to assimilate it to the Suez Canal the navigable depth should if possible be about 26 feet. On the north side the distance from high water mark to 30 feet at low water is, according to a chart by the Surveyor-General at Colombo, upwards of a mile; on the south side the distance to the same depth is still greater, so that very considerable works of dredging will be necessary in forming and afterwards maintaining the entrances to the canal. The south end of the canal is under shelter of a coral reef, but the north end may perhaps require to be protected by breakwaters. The cost of cutting the canal has been named at £440,000.

Isthmian canal.

The other scheme to which we referred has a far higher stage of importance, its object being to separate the continents of North and South America, and to give a free navigation between the Atlantic and the Pacific Oceans, by overcoming the physical difficulties presented by the climate and the geological formation of the Isthmus that separates the two

[1] *The History of the Suez Canal*, by F. de Lesseps, translated by Sir H. D. Wolff, 1876.

seas, to which has to be added the problem of making and maintaining a deep-water channel from the ocean to the entrances to the canal

This bold scheme, first proposed in the 16th century, has at various intervals been the subject of many deputations and much correspondence between the American and European powers; and more recently, in 1845, when Louis Napoleon was confined as a state prisoner at Ham, he spent much of his exile in investigating its practicability, and in making arrangements for carrying out, under the name of the "Napoleon Interoceanic Canal," a passage between the two seas from Port San Juan to Port Realejo. But we have not space to record the various early attempts to realize this project, and must therefore confine our remarks to giving an idea of the present state of negotiations regarding it.

The recent enormous growth of Californian trade has led to the revived consideration of the scheme by the United States of America, who would be the greatest gainers by the work, and therefore are its most natural promoters; and what we propose is to give a sketch of the present state of the question, as afforded by reports and documents recently issued by the Government of the United States, from which alone authentic information can be derived.

It appears from these documents that two routes have recently been investigated:—*First*, that of the Isthmus of

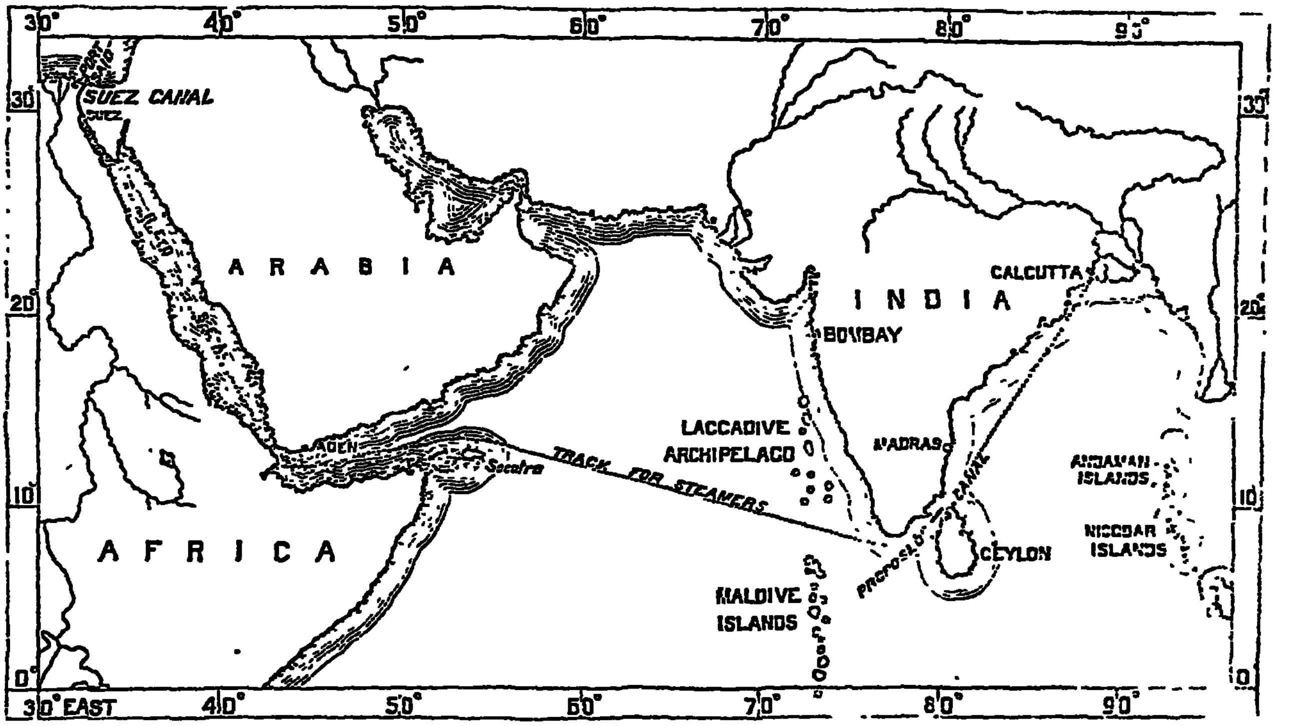


Fig. 11.—Showing Suez Canal and Proposed Canal at Ceylon.

Darien, shown in fig. 12, under the direction of Commander Selfridge, U.S.N.; and *second*, that of Nicaragua, also shown in fig. 12, under the direction of Commander Lull, U.S.N. To both of these expeditions were attached a large staff, including naval officers, civil engineers, surveyors, mineralogists, &c., and their surveys appear to have extended over the years 1871, 1872, and 1873.

Proposed Darien Canal. The results of these surveys are thus summarized in the report of the Secretary to the Navy, submitted to the Government of the United States in 1873, from which we take the following information. Of the Darien route, it is said that it includes 100 miles of navigation of the River Atrato, which has been carefully sounded, and found to be fully capable of being navigated by the largest class of ocean-steamers. Between Atrato and the Pacific a canal or artificial cut must be formed of 28 miles in length. The canal for 22 miles of this distance passes through a plain having a gradual rise of 90 feet. There will then remain 6 miles to the Pacific, three of which will be in moderate open cutting, and 3 miles will be tunneling. It is estimated that the work will cost between £10,400,000 and £12,600,000, and that it can be completed in ten years. The tunnel, being for the passage of ships of the largest size, is proposed to be 112 feet high and 60 feet wide, and is to have 87 feet of clear headway above the surface of the water. The canal is to be 25 feet in depth, with a bottom width of 50 feet, and a surface width of 70 feet. The locks, twenty in number, are to be 427 feet long, 54 feet wide, with a lift of 10 feet. The water supply is to be derived from the Napipi river, and the gaugings and observations made on evaporation lead to the conclusion that there is a great excess of water above the supply required for the canal. Commander Selfridge gives two alternative schemes, by which the tunneling is increased in length and the number of the locks diminished, at an estimated cost of from £17,000,000 to £18,000,000 respectively.

The exploration of the Nicaraguan route, under Commander Lull, the position of which is also shown in fig 12, is said to have proved the existence of a practicable route, having Lake Nicaragua as its summit-level, being 107 feet above mean tide. It is proposed by this route to connect the lake with the Pacific by a canal 16·3 miles in length, beginning at the mouth of the Rio del Medio and terminating at Brito. The first 7·5 miles will require an excavation averaging 54 feet in depth, and will be the most expensive part of the whole work. Ten locks and one tide-lock will be required between the lake and the sea. There will be 56 miles of lake navigation. Proposed Nicaragua Canal.

Slack-water navigation in the San Juan from its head to the mouth of San Carlos is considered perfectly feasible, and it is proposed to improve the river by four dams, at Castillo Rapids, Balas Rapids, Machuca Rapids, and at the mouth of the San Carlos River, at all of which places there are excellent sites for dams. A short section of canal will

one lock will be required to get around each of the upper three dams. From the fourth dam to Greytown in the Caribbean Sea an independent canal will be required 41·9 miles in length with seven locks, which apparently presents no difficulty. The total length of the proposed canal is 61·7 miles, and no tunnel is required. The harbour of Greytown has been partially destroyed by a silt which comes from the San Carlos, and others of the lower tributaries of the San Juan, and the branch of the river leading to Greytown has become so much filled up that it is now, at the lowest stage of the water, only 324 feet wide and 6 inches deep at the fork. It is proposed to shut off this branch entirely and send all the silt-bearing water through the Colorado mouth, which empties into the sea 18 miles from Greytown, and to admit to the harbour only the water of the canal, which, being drawn from the main river above the mouth of the San Carlos, will be perfectly clean. The harbour then cleared out, will leave nothing to deteriorate it again.

Short breakwaters will be required to protect the entrances from the surf, both of which are included in the estimate for the work.

Careful gauging at the lowest stage shows that Lake Nicaragua, which has a surface area of 2700 square miles, and a drainage area of 8000 square miles, will supply thirty-eight times the maximum possible demand of water.

The depth of water is to be 26 feet, the width at bottom 72 feet, and at surface 150 feet. The locks, twenty-one in

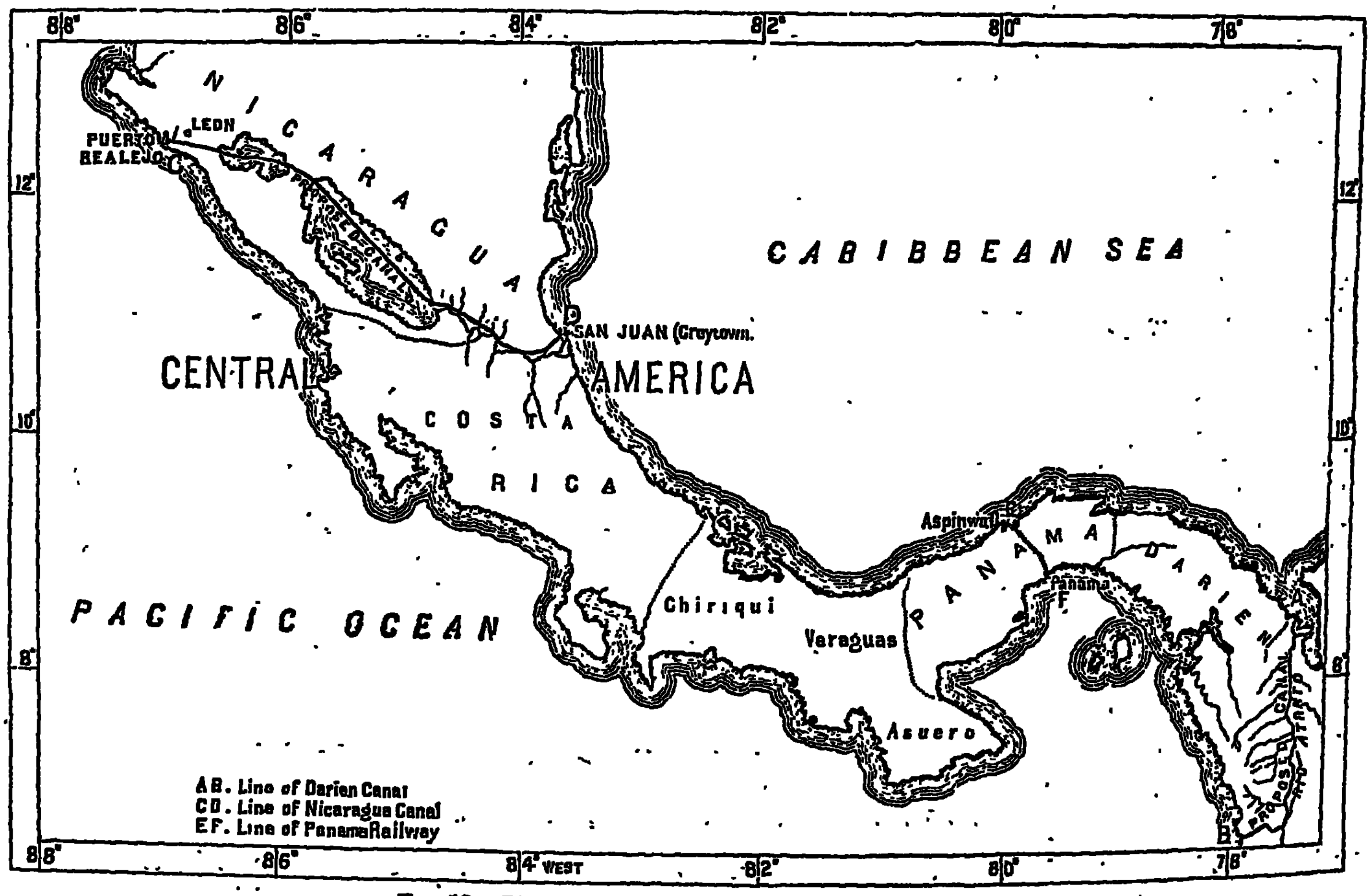


FIG. 12.—Lines of proposed Darien and Nicaragua Canals.

number, with a lift of from 8 to 10 feet, are to be 400 feet long and 72 feet wide. The estimate is stated at £15,900,000.

M. Lesseps, in a lecture on the Suez Canal, delivered before the Société des Gens de Lettres at Paris, has given it as his opinion that unless the Atlantic and Pacific can be united by simply piercing the Isthmus from sea to sea without locks, as at the Suez Canal, the proposed scheme cannot possibly succeed as a commercial enterprise, because of the inadequacy of a canal with locks to pass the traffic that will frequent it, and also of the uncertainty of sufficient water to supply the lockage and evaporation. This latter objection, however, seems to be disproved by the researches of the American engineers who have investigated the subject. A further difficulty arises in maintaining a sufficient sea-water depth to the canal even after it has been formed. On this point the writer of this article, judging from documents prepared under the sanction of the Government of the United States and submitted to him by an authorized official of the Government, arrived at the conclusion that there are very formidable obstacles to the establishment and future maintenance of a deep-water entrance to the proposed Nicaraguan Canal at Greytown, in the Caribbean sea. These obstacles involve the engineering problem of maintaining permanent deep water through an extensive shallow foreshore composed of soft materials and exposed to heavy seas. The reports state "that at Greytown there are now islands where twenty years ago there was water enough to float a frigate." It remains to be seen whether the same difficulties apply to the entrance to the proposed Darien scheme; and, to show that such fears may not be unfounded, we may remind the reader that the difficulties exist, as we have stated, at the Mediterranean entrance to the Suez Canal.

The question as to the best route for transit between the Atlantic and Pacific is, it will be seen, still far from being solved, but the necessity for free access from sea to sea remains an acknowledged fact. Its importance, especially to the United States, but in some degree to all the world, is such that, great as are the engineering difficulties, this long-cherished bold *idea* may yet become a stupendous *reality*. (D. S.)

Reference is made to the following works:—Chapman, *On Canal Navigation*; Frisi, *On Canals*; Fulton, *On Canal Navigation*; Vallancy's *Treatise on Inland Navigation*; Tatham's *Economy of Inland Navigation*; *Principles and Practice of Canal and River Engineering*, by David Stevenson, 2d edition, A. and C. Black, Edinburgh; *Report of the Secretary of the United States Navy for* 1873

CANAL, or CANALETTO, ANTONIO (1697–1768), a Venetian painter, born 18th October 1697, was bred with his father, a scene-painter at Venice, and for some time followed his father's line of art. In 1719 he went to Rome, where he employed himself chiefly in delineating ancient ruins, and particularly studied effects of light and shade, in which he became an adept. He was the first painter who made practical use of the camera lucida. On returning home he devoted his powers to views in his native city, which he painted with a clear and firm touch and the most facile mastery of colour in a deep tone, introducing groups of figures with much effect. In his latter days he resided some time in England. His pictures, in their particular range, still remain unrivalled. He died on 20th August 1768. Bellotto (commonly named Bernardo) Canaletto, 1724–1780, was his nephew and pupil, and painted with deceptive resemblance to the style of the more celebrated master.

CANANDAIGUA, a town in the United States, capital of the county of Ontario in New York, is situated at the northern end of a lake of the same name, 29 miles S.E. of Rochester by rail, in 42° 54′ N. lat. and 77° 27′ W. long. It is a railway junction of some importance, and has a court-house, an academy, and two printing-offices. Its incorporation dates from 1815. The lake is a beautiful sheet of water about 15 miles long, with a breadth varying from less than a mile to more than a mile and a half. It is about 437 feet above Lake Ontario. The population of the town is 4862, and of the township 7274.

CANANORE. See KANANORE.

CANARA. See KANARA.

CANARY (*Fringilla canaria*), a well-known species of Conirostral Bird, belonging to the family *Fringillidæ* or Finches. It is a native of the Canary Islands and Madeira, where it occurs abundantly in the wild state, and is of a greyish-brown colour, slightly varied with brighter hues, although never attaining the beautiful plumage of the domestic bird. It was first domesticated in Italy during the 16th century, and soon spread over Europe, where it is now the most common of cage-birds. During the 350 years of its domestication, the canary has been the subject of careful artificial selection and of crossing with allied species, the result being the production of a bird differing widely in the colour of its plumage, and in a few of its varieties even in size and form, from the original wild species. The prevailing colour of the most admired varieties of the canary is yellow, approaching in some cases to orange, and in others to white; while the most robust birds are those which, in the dusky green of the upper surface of their plumage, show a distinct approach to the wild forms. The least prized are those in which the plumage is irregularly spotted and speckled. In one of the most esteemed varieties, the wing and tail feathers are at first black—a peculiarity, however, which disappears after the first moulting. Size and form have also been modified by domestication, the wild canary being not more than 5½ inches in length, while a well-known Belgian variety usually measures 8 inches. There are also hooped or bowed canaries, feather-footed forms, and top-knots, the latter having a distinct crest on the head; but the offspring of two such top-knotted canaries, instead of showing an increased development of crest, as might be expected, are invariably bald on the crown. Most of the varieties, however, of which no fewer than twenty-seven were recognized by French breeders so early as the beginning of last century, differ merely in the colour and the markings of the plumage. Hybrids are also common, the canary breeding freely with the siskin, goldfinch, citril, greenfinch, and linnet. Some of the hybrids thus produced, are, according to Darwin, almost completely fertile, but they do not seem to have given rise to any distinct breed. It is the female canary which is almost invariably employed in crossing, as it is difficult, if not impossible, to get the females of the allied species to sit on the artificial nests used by breeders. In a state of nature canaries pair, but under domestication the male bird has been rendered polygamous, being often put with four or five females; still he is said to show a distinct preference for the female with which he was first mated. It is from the others, however, that the best birds are usually obtained. The canary is very prolific, producing eggs, not exceeding six in number, three or four times a year; and in a state of nature it is said to breed still oftener. The work of building the nest, and of incubation, falls chiefly on the female, while the duty of feeding the young rests mainly with the cock bird. The natural song of the canary is loud and clear; and in their native groves the males, especially during the pairing season, pour forth their song with such ardour as sometimes to burst the delicate vessels of the throat. The males appear to compete with each other in the brilliancy of their melody, in order to attract the females, which, according to Bechstein, always select the best singers for their mates. The canary readily imitates the notes of other birds, and in Germany and especially Tyrol, where the breeding of canaries gives employment to a large number of people, they are usually placed for this purpose beside the nightingale. In England they are taught in a similar way to imitate the woodlark. They are also taught to whistle one or two airs, and even to articulate a few words. The female possesses considerable vocal powers, but her notes are weaker than the male's, and her song usually less consecutive.

CANARY ISLANDS, THE, lie in the North Atlantic Ocean, between the parallels of 27° 4′ and 29° 3′ N. lat., and the meridians of 13° 3′ and 18° 2′ W. long. The seven principal islands cover an area of 3256 English sq. miles, and had a population of 237,036 in 1860:—

	Teneriffe.	Grand Canary.	Palma.	Lanzarote.	Fuerteventura.	Gomera.	Hierro
Area.........	877·7	758·3	718·5	323·5	325·1	169·7	82·2
Population,	93,709	68,970	31,135	15,837	10,936	11,350	5026

Fuerteventura lies nearest to the African coast, the interval being between 50 and 60 miles. Besides these there are many islets, most of which are uninhabited.

History.—There is ground for supposing that the Phœnicians were not ignorant of the Canaries. The Romans, in the time of Augustus, received intelligence of them through Juba, king of Mauritania, whose account has been transmitted to us by the elder Pliny. He mentions "Canaria, so called from the multitude of dogs of great size," and "Nivaria, taking its name from perpetual snow, and covered with clouds," doubtless Teneriffe. Canaria was said to abound in palms and pine trees. Both Plutarch and Ptolemy speak of the Fortunate Islands, but their description is so imperfect that it is not clear whether the Madeiras or the Canaries are referred to. There is no farther mention of them until we read of their rediscovery about 1334, by a French vessel driven amongst them by a storm. A Spanish nobleman thereupon obtained a grant of them, with the title of king, from Clement VI., but want of means prevented him from carrying out his project of conquest. Two expeditions subsequently set out from Spanish ports, and returned without having taken possession. At length three vessels, equipped by Jean de Béthencourt, a gentleman of Normandy, sailed from Rochelle in 1402, and bent their course to the Canaries. He landed at Lanzarote and Fuerteventura, but being opposed by the natives, and finding himself deficient in means to effect his purpose, he repaired to the court of Castile, and obtained from Henry III a grant of the islands, with the title of

king, he sailed in 1404 with a strong force, which mastered Lanzarote, Fuerteventura, Gomera, and Hierro, without bloodshed. Being repulsed in his attempts on Palma and Canary, he returned to Europe in 1408 to obtain further assistance. He was well received at the Castilian court, where he was promised aid; but he died shortly afterwards in France. Bethencourt's nephew had been left governor of the islands, and claimed to succeed to his uncle's rights. Being charged with many acts of misgovernment, he went to Spain to clear himself, and whilst there sold his rights to Don Enrique de Guzman, who, after expending large sums in fruitless endeavours to reduce the unconquered islands, sold them to another Spaniard named Paraza. His successors, about 1461, took nominal possession of Canary and Teneriffe, but the natives effectually resisted their occupation of them. Meantime it appeared that Jean de Bethencourt's nephew had fraudulently made a second sale of the islands to Portugal, and the difference thus arising between the crowns of Spain and Portugal was ended by the cession of the islands to the former. Grand Canary, Teneriffe, and Palma remaining unsubdued in 1476, Ferdinand and Isabella of Spain compelled Paraza's successors to sell those islands to the crown; and the following year 1000 men were despatched to reduce them. After much bloodshed, and with reinforcements from the mother country, the Spaniards, under Pedro de Vera, became masters of Grand Canary in 1483. Palma was conquered in 1491, and Teneriffe in 1495, by Alonzo de Lugo. All the islands still continue in the possession of Spain.

Inhabitants.—As to the derivation of their original inhabitants, the Guanches, nothing certain is known. The most probable supposition is that they came from the adjoining coast of Africa. Pliny states that the islands were uninhabited at the time of which he wrote. If this were so, we might infer, from the absence of any trace of Mahometanism amongst the people found there by the Spaniards, that the migration took place between the time to which his account refers and the time of the conquest of Barbary by the Arabs. Many of the Guanches fell in opposing the Spanish invasion, many were sold by the conquerors as slaves, and many conformed to the Roman Catholic faith and intermarried with the Spaniards,—so that all trace of them as a distinct race is lost. They were said to be of tall stature, and Humboldt styles them the Patagonians of the Old World; but the skeletons of Guanches when measured have been found to be less than average skeletons of Europeans. The Guanches embalmed the bodies of their dead, and placed them in caves; and many mummies have been found at different times in a state of extreme desiccation, each weighing not more than 6 or 7 lb. Two inaccessible caves in a vertical rock by the shore, three miles from Santa Cruz (Teneriffe), are said still to contain bones. A few words of the languages spoken by the ancient inhabitants have been preserved, and a resemblance of some of them to words of North African dialects has been noticed. On the other hand, the Guanches had customs, such as that of preserving their dead, in which they differed from the Berbers. Councillor Von Löher, one of the most recent investigators of the question, finds that the names of places in the interior of the island are generally either of Berber or of Teutonic origin, and maintains that the Guanches were in all probability the descendants of Vandal and Gothic immigrants.

The present inhabitants are slightly darker than the people of Spain, but in other respects are scarcely distinguishable. The men are of middle height, well-made, and strong; the women are not striking in respect of beauty, but they have good eyes and hair. Spanish is the only language in use. The people have most of the traits of the people of the peninsula; they are sober, but given to gambling; they are quick, but lazy, faithless, and superstitious. The lower orders are quite illiterate, and the better classes not very enlightened. A few booksellers' shops of a minor description exist at Santa Cruz and Las Palmas. The sustenance of the lower classes is chiefly composed of fish, potatoes, and *gofio*, which is merely Indian corn or wheat roasted and then, when ground, kneaded with water or milk.

Government, &c.—The Archipelago is politically considered part of the province of Andalusia. The governor-general, who resides at Santa Cruz, has chief command both in civil and military affairs. The actual administration of affairs is in the hands of two lieutenant-governors, who reside at Santa Cruz and Las Palmas. On the other islands are deputy-governors, acting under the lieutenant-governor to whose district they belong. The military force is composed of a battalion of soldiers of the line, numbering about 1000 men; six regiments of militia, amounting to about 8000 men, distributed amongst the islands; and a few companies of artillery. There is a military commander on each island. The great court of appeal sits at Las Palmas. Courts of first instance sit at Santa Cruz, Orotava, and Las Palmas. The land in great part is strictly entailed. The islands form two bishoprics, Teneriffe and Grand Canary. The whole ecclesiastical revenue is estimated at upwards of £36,000. The monkish establishments have been suppressed, and such of the monasteries and convents as are not kept up for secular purposes are falling to ruin. No form of religion except the Roman Catholic is tolerated.

Climate and Meteorology.—From April to October a north or north-east wind of more or less strength blows upon the islands, commencing at 10 A.M. and continuing until 5 or 6 P.M. In summer this wind produces a dense stratum of sea cloud (cumuloni), 1000 feet thick, whose lower surface is about 3500 feet above the sea at Teneriffe. This does not reach up to the mountains, which have on every side a stratum of their own, about 500 feet thick, the lower surface being about 2500 feet above the level of the sea. Between these two distinct strata there is a gap through which persons on a vessel approaching or leaving the island may obtain a glimpse of the peak. Travellers who ascend the mountains look down on these stationary layers of cloud. The sea cloud conceals from view the other islands, except those whose mountains pierce through it. On the south-west coasts there is no regular sea or land breeze. In winter they are occasionally visited by a hot south-east wind, called Levante, from the African continent, producing various disagreeable consequences on the exposed parts of the person, besides injuring the vegetation, especially on the higher grounds. Locusts have sometimes been brought by this wind. In 1812 it is said that locusts covered some fields in Fuerteventura to the depth of 4 feet. Hurricanes, accompanied by waterspouts, sometimes cause much devastation; but, on the whole, these islands are singularly free from such visitations. The climate generally is mild, dry, and salubrious. On the lower grounds the temperature is equable, the daily range seldom exceeding 6° Fahr. The rainy season occurs at the same period as in southern Europe. The dry season is at the time of the trade-winds, which extend a few degrees farther north than this latitude. "In no part of the world is the barometer more susceptible of atmospheric changes than amongst the Canary Islands. A rapid rise is the sure precursor of an easterly wind, whilst the contrary as certainly indicates a change to west or south-west" (Lieut. Arlett).

Agriculture, Manufactures, and Commerce.—In ordinary years sufficient grain and potatoes are produced to supply the wants of the islands. The soil on the lower part of the islands, where water is plentiful, is productive; in some places two crops of Indian corn and one of potatoes

can be obtained from the same piece of ground in a twelvemonth. Except at Fuerteventura, the vine is much cultivated, but chiefly at Teneriffe, the best wines being produced on the north-west coast. None, however, is considered so good as the wine of Madeira. The most esteemed kind is sent to England under the name of Vidonia. The grape disease made its appearance at the Canaries in 1853, and destroyed nearly the whole crop. Previously the total annual produce was estimated at about 40,000 pipes, of which 25,000 pipes were produced in Teneriffe. Between 8000 and 9000 pipes were exported. The price per pipe on board ranged from £8 to £20. Some of the wine is distilled into good brandy. Sumach, canary-seed, and a little flax are grown. Sweet potatoes, maize, gourds, pumpkins, tara (*Colocasia antiquorum*), lentils, *Cicer arietinum*, beans, kidney beans, and lupines are extensively cultivated for food. From bad management the fruits are generally inferior. They include oranges, figs, bananas, dates, pineapples, pomegranates, papaws, guavas, custard apples, and prickly pears. There are no cocoa-nut trees or bread-fruit trees. A little oil is obtained from the olive in Grand Canary. The agave is abundant, and supplies a material for ropes, girths, &c. The leaves of the date palm are made into hats and baskets. A good deal of orchil-lichen is gathered for exportation; and the ice-plant is grown in small quantity for barilla. The sugar manufacture, once largely carried on, has fallen before the American and West Indian trade; the only two existing mills are on Palma. Wine having been for some time so little remunerative, other products have received attention, the chief being cochineal. This insect, which feeds on a species of cactus, was introduced in 1825, and is now largely produced on all the islands,—land formerly occupied by grain and vines being devoted to its cultivation. In 1873 upwards of 5,728,000 lb, of the total value of 13,894,225 pesetas, or about £555,849, were exported, principally to France and England. The silkworm is reared to a small extent, chiefly on Palma. Raw silk is exported, and some is manufactured on the spot into stockings, ribands, &c. Some linen and woollen stuffs of a coarse kind are made for home consumption, but the great bulk of the clothing in use is of British manufacture. The island goats (a peculiar and esteemed breed) furnish milk, from which butter and cheese are made. Pigs and sheep of a small coarse-woolled breed are numerous. Horses and cattle are scarce; domestic fowls and rabbits are plentiful. Asses and mules are much used. A fishery on the African coast, which gives employment to many persons, has existed from an early period. The fish, principally bream, is salted and largely consumed at the Canaries.

There is a good deal of intercourse by means of boats and small sailing vessels amongst the different islands. In this way wine, raw silk, cochineal, barilla, and dried fruits are taken to the places of export; and grain is conveyed from those islands where it is abundant to those where the supply is deficient. The principal foreign trade is with England, the chief articles of export being wine, cochineal, barilla, and orchil. The imports consist of iron, metal goods, glass, crockery, leather, and silk, cotton, and woollen manufactures. There is also a considerable trade with the United States and the countries bordering the Mediterranean. With Hamburg and France an exchange of commodities takes place. The ships employed in this commerce are foreign, chiefly British; but the islanders send a few vessels of their own with brandy, coarse earthenware, and silk goods to the Spanish West Indies, bringing back cigars, sugar, coffee, rum, cocoa (the material of chocolate), and a few other articles. Santa Cruz, Orotava, and Las Palmas are the only ports engaged in foreign trade; nearly 300 vessels enter these ports in the course of a year. In 1852 the ports were practically made free—the small duty of 2s. per cent. only being now levied upon imported goods, with the exception of tobacco, which pays 5d. per lb., and cigars which pay 10d. per lb. Spanish steamers ply between Cadiz and Santa Cruz. The Spanish Government packet on its outward voyage to Havana touches at Santa Cruz once a month; and the same port is visited by the English mail steamers in their voyages to and from the African coast.

Zoology.—The indigenous mammals and reptiles of the Canary Islands are very few in number. Of the former, only species of dog, of swine, of goat, and of sheep were found upon the island by the Spanish conquerors. The race of large dogs which is supposed to have given a name to Canary has been long extinct. A single skeleton has been found, which is deposited in one of the museums at Paris. The ferret, rabbit, cat, rat, mouse, and two kinds of bat have become naturalized. The ornithology is more interesting, on account at once of the birds native to the islands and the stragglers from the African coast. The latter are chiefly brought over in winter when the wind has blown for some time from the east. Among the former are some birds of prey, as the African vulture, the falcon, the buzzard, the sparrow-hawk, and the kite. There are also two species of owl, three species of sea-mew, the stockdove, quail, raven, magpie, chaffinch, goldfinch, blackcap, canary bird, titmouse, blackbird, house-swallow, &c. The bird with the sweetest song is a variety of the blackcap or *Sylvia atricapilla*. As to the insects, mention may be made of a species of gnat or mosquito which is sometimes troublesome, especially to strangers, and the cockroach. The list of reptiles is limited to three lizards and a frog. The only fresh-water fish is the eel. The marine fishes are not numerous, the reason perhaps being that the steepness of the coast does not allow seaweed to grow in sufficient quantity to support the lower forms of marine animal life. Whales and seals are occasionally seen. The cuttle-fish is abundant, and is sought for as an article of food.

Botany.—The position of mountainous islands like the Canaries, in the sub-tropical division of the temperate zone, is highly favourable to the development, within a small space, of plants characteristic of both warm and cold climates. Von Buch refers to five regions of vegetation in Teneriffe:—1. From the sea to the height of 1300 feet. This he styles the African region. The climate in the hottest parts is similar to that of Egypt and southern Barbary. Here grow, among the introduced plants, the coffee-tree, the date-palm, the sugar-cane, the banana, the orange tree, the American agave, and two species of cactus, and among indigenous plants, the dragon tree on the north-west of Teneriffe. A leafless and fantastic euphorbia, *E. canariensis*, and a shrubby composite plant, *Cacalia Kleinia*, give a character to the landscape about Santa Cruz. 2. Between 1300 feet and 2800 feet. This is the region of South European vegetation, the climate answering to that of southern France and central Italy. Here flourish the vine and the cereals. 3. The region of indigenous trees, including various species of laurel, an *Ardisia*, *Ilex*, *Rhamnus*, *Olea*, *Myrica*, and other trees found wild also at Madeira. The clouds rest on this region during the day, and by their humidity support a vegetation amongst the trees, partly of shrubs, and partly of ferns. It extends to the height of 4000 feet. 4. The region of the beautiful *Pinus canariensis*, extending to the height of 6400 feet; here the broad-leaved trees have ceased to grow, but arborescent heaths are found throughout its whole extent, and specimens of *Juniperus oxycedrus* may be met with. 5. The region of Retama (*Cytisus nubigenus*), a species of white-flowering and sweet-scented broom, which is found as high as 11,000 feet. At the upper edge of this region a [illegible]

violet clings to the soil, and above there is nothing but a little lichen. The number of wild flowering plants may be estimated at 900, upwards of 270 of which are peculiar to the Canaries. The forms of vegetation must in the main be considered North African, since the origin of many of those which they have in common with Southern Europe should be looked for in Africa. The character of the vegetation in Lanzarote and Fuerteventura islands, composed of extensive plains and low hills, with few springs, is different from that of the other islands, which are more elevated and have many springs. The wood is more abundant, and the vegetation more luxuriant.

Geology.—Recent soundings have proved that the Canary Islands, like the other island groups of the North Atlantic, are the summits of mountains that are surrounded by an ocean of great depth. The lower and exterior portion of these islands consists for the most part of basalt, compact, vesicular, or scoriaceous, interstratified with beds of variously-coloured tufa. The compact variety of basalt frequently contains scattered grains and crystals of augite and olivine. In some cases the rock is chiefly trachyte. In Grand Canary the fossils contained in the tufas prove that movements of elevation began in the Upper Miocene period. They continued down to the Pleistocene period, for raised beaches containing shells of the recent period exist both in Teneriffe and Grand Canary. Simultaneously with the upheaval subaërial eruptions were taking place. Many of the superimposed streams of lava are divided from one another by red bands of *laterite*, probably ancient soils formed by the decomposition of the surfaces of the lava, and showing that the building up of the islands was a slow process. In Teneriffe the basalt and tufa form an exterior mass, through which in the centre emerge the felspathic or trachytic rocks forming the nucleus of the volcanic cone, and over them fragments of pumice and streams of modern lava have been thrown. These trachytic rocks contain numerous disseminated crystals of glassy felspar. Obsidian is found in several parts of Teneriffe, and is usually spotted with white crystals of felspar. The few minerals that have been found in the Canary Islands are those characteristic of volcanic regions. A little iron exists, but is not turned to account. In no part of Teneriffe has there been discovered any sedimentary rock. The old lavas in Lanzarote are covered by a thin layer of white concretionary limestone, the origin of which is obscure. In Grand Canary and Fuerteventura there is also calcareous stone, but its nature does not appear to be known.

[Te]neriffe. TENERIFFE, the largest island of the group, lies between Grand Canary and Gomera. It is of irregular shape, 60 miles in length, with an extreme breadth of 30 miles. Not more than one-seventh is cultivable. A chain of mountains traverses the island in the direction of its greatest length, and in the middle of the broadest part rises the celebrated Peak, locally known as the Pico de Teyde, which, with its supports and spurs, occupies nearly two-thirds of the whole island. It has a double top; the highest point, El Piton, is 12,200 feet above the sea; the other, Chahorra, connected with the first by a short narrow ridge, has a height of 9880 feet. They are both orifices in the same grand dome of trachyte. Neither reaches the line of perpetual snow. There is, however, a natural cavern, 11,050 feet above the sea, where snow is preserved all the year. Snow remains about four months on the upper part of the Peak.

For more than one-half of its circumference the base of the true peak rises from an elevated but comparatively level tract, called by the Spaniards *El Llano de la Retama* (*retama* being the name of the *Cytisus nubigenus* which abounds there), and by the English the Pumice-Stone Plains. On the south-east, south, and south-west there is a high curved ridge overlooking the Pumice-Stone Plains, and presenting a very steep face to the Peak. This is the analogue of the Somma ridge of Vesuvius. Between the ridge and the sea the slope is more gradual, and there are intervening table-lands. A path used by the country people in going from one side of the island to the other crosses this ridge at the height of 8000 feet. Peaks rise from the ridge, one of which (*Guajara*) attains the height of 8900 feet. This ridge (the Llano) and the modern volcanic cone resemble in aspect a fortress with circular ramparts and a fosse. The ramparts are about 8 miles in diameter, and tower in some places more than 1500 feet above the fosse. They consist, as shown in the sections, of beds of trachyte, greenstone, and tufa of various thicknesses, and intersected by dykes and faults. On the north-west comparatively late eruptions have filled up the fosse. The modern cone, then, is a pile of lava, pumice, and ashes, thrown up in an ancient crater which had become greatly enlarged either by a falling in of the upper part of the cone, or by a series of violent explosions. Both El Piton and Chahorra have craters on their summits, from which issue steam and a little sulphureous vapour. The crater on El Piton is partly surrounded by a wall of lava, which has been made white by the action of sulphureous vapours, and every crevice contains small crystals of sulphur. The thermometer rises considerably when thrust into the ground. The crater is about 300 feet across, with a depth of 70 feet. The average slope of the lower part of the cone is 28°; that of the sugar loaf at the top is 33°. The crater on Chahorra has a diameter of 4000 feet; its depth is scarcely 150 feet. The view from the highest point, when no clouds intervene, is very extensive. All the islands of the Archipelago are visible, and the horizon is 140 miles distant. Neither the coast of Africa nor the island of Madeira is within the range of vision.

The ascent of the Peak is usually made from Orotava, on the northern side of the island. After the cultivated grounds are left, the region of arborescent heaths is crossed. This zone extends over the zones of laurels and pines which have here disappeared. Above this is a belt covered with *codeso* (*Adenocarpus frankenioides*), and this extends to the region of *retama*; the first bushes of which are met with at the pass which admits the traveller into the *Llano de la Retama*. The scenery here is in striking contrast with what it has previously been. Instead of a steep and rugged ascent among black basaltic rocks, the traveller enters upon gently sloping ground, covered to a considerable depth with white pumice gravel, amongst which spring bushes of retama. The tender shoots of this shrub serve the wild goats for food, and the flowers yield a rich honey to the bees. The entrance to the Llano at a sort of portal (called Portillo) between two basaltic hills, is about 7000 feet above the sea. Between two and three hours are consumed in crossing the Llano to the base of the cone, the lower part of which (*Monton de Trigo*) is ascended to a point 9750 feet above the sea, called *Estancia de los Ingleses*, where the mules are usually left, and where travellers frequently pass the night. Then comes the Malpays, 1000 feet in altitude, consisting of rough black lava streams broken up into blocks and stones. These cease at the neck called Rambleta, the lip of an older crater over which the lava poured before the sugar-loaf cone of pumice and ashes was thrown up. The pumice is in such quantity that at a distance it has the appearance of snow coating the Peak. From twenty to twenty-four hours are consumed in ascending the Peak and returning to Orotava.

To the north-west of the grand cone some thousands of feet below Chahorra, there are many small cones of eruption, showing that the intensity of volcanic action was greatest on this side. Eastward from the ridge bounding the Pumice-Stone Plains extends a chain of mountains to

the north-eastern extremity of the island. The highest peaks are Izana (7374 feet), Perejil (6027), and Cuchillo (5467).

We have no account in history of eruptions from either crater of the Peak. In 1795 a great quantity of lava was poured out from three vents on the eastern side; and in the same year lava streams issued from a crater near Guimar, half-way between Santa Cruz and the Peak. In the year 1706, a vent on the north-western side of the Peak discharged a copious stream, which flowed down to the sea, and nearly filled up the harbour of Garachico. For three months in 1798 much lava and other volcanic matter were ejected from orifices to the west of Chahorra.

Santa Cruz de Santiago, on the south coast, is the residence of the governor-general of the Canaries, the civil lieutenant-governor of the Teneriffe district, and the military governor of the island. Its position is 28° 28′ 30″ N. lat. and 16° 16′ W. long. It is a well-built and tolerably clean town of 10,830 inhabitants, lying on a small plain bounded by bare and rugged volcanic rocks, amongst which lie narrow valleys called *barrancos*. Scarcely any vegetation, except thorny cactuses and euphorbias, is to be seen in the neighbourhood. The streets are at right angles to each other, narrow, but provided with side walks. There are three public squares. The houses are generally low, with flat roofs; those of the better class are large, with a court-yard in the middle, planted with shrubs in the Spanish fashion. The market is well supplied with meat, fruits, and vegetables. Good water is brought from the fine forest of Mercedes, which is composed of laurels and other indigenous trees. A British consul resides in the town, and several English families. The accommodation for strangers is neither plentiful nor good. The Spanish cloak is much worn by the men, and the white mantilla by the women. Dromedaries brought from Lanzarote and Fuerteventura are in use for the conveyance of merchandise and in agricultural operations. A good animal costs from 30 to 40 dollars. A few wheel-carriages are in use. Much ground in the neighbourhood is planted with cactus (*Opuntia Tuna*) for the support of the cochineal insect. The town is defended by several batteries; and it was by a shot from one of these that Lord Nelson lost his arm, when he unsuccessfully attacked the place in 1797. Some English flags lost on that occasion are still hanging in one of the churches. The anchorage is good, and a mole facilitates landing. About 200 vessels annually visit the port. The climate is dry and moderately warm, the annual mean being 71° Fahr. The mean of the coldest month is 63°·8 Fahr., and of the hottest 78°·8 Fahr. Rain falls on an average on thirty-six days in the year.

Laguna (population 4645) stands at the distance of four miles from Santa Cruz, in the centre of a plain where much grain is produced, elevated 1725 feet above the sea, and nearly surrounded by mountains. The situation is beautiful, but the town itself is gloomy. It contains several deserted convents and a cathedral. In summer the temperature is refreshingly cool, and for that reason Laguna is then resorted to by the rich of Santa Cruz. In winter it is cold and damp, the plain being frequently laid under water by rain. This is in consequence of three aerial currents meeting there, from the north, east, and south-west. The mean temperature of the year is 63°·2 Fahr. Snow has never been known to fall here. The humidity of the atmosphere is shown by the quantities of sempervivum growing on the houses and walls.

A good road connects Santa Cruz and Orotava, a town on the north coast 25 miles distant. It passes through Laguna and Matanza,—a place deriving its name from the overthrow of the invading Spaniards by the Guanches in 1494. All travellers speak in terms of warm admiration of the scenery in this part of the island. Humboldt says he "never beheld a prospect more varied, more attractive, more harmonious in the distribution of the masses of verdure and of rocks, than the western coast of Teneriffe." Date palms form a striking feature in the landscapes. The town of *Orotava* (population 3228) is 1040 feet above the sea. The houses are solidly built, but it has a deserted aspect. A stream of water is conducted through every street. The famous dragon-tree, which so many travellers have described, was lately destroyed by a storm. *Port Orotava*, three miles from the town, is a clean place, with between 4000 and 5000 inhabitants, amongst whom are three or four English families. The streets are broad and the houses well built. The roadstead, protected by a fort and some batteries, affords little or no shelter against wind. The botanic garden, founded by a patriotic Spanish nobleman, is now in the hands of a market-gardener. At *Icod de los Vinos*, a pretty town of 4000 inhabitants, farther to the west, in a fertile district, is a dragon-tree, the largest now existing in the island. The stem near the ground has a circumference of 38 feet, and its height is upwards of 60 feet. Near the town is an immense cavern, in which many Guanche bones are to be seen. There are several other towns of less importance, principally in the north-west, not far from the coast. The highest inhabited place is Chasna, on a plain more than 4000 feet above the sea, to the south of the Peak.

Grand Canary

GRAND CANARY (*Gran Canaria*), the most fertile island of the group, is nearly circular in shape, with a diameter of 24 miles and a circumference of 75 miles. The interior is a mass of mountain, reaching to the height of about 6000 feet above the sea, with ravines radiating to the shore. Its highest peak, Los Pexos, is 6400 feet above the sea. Large tracts are covered with native pine (*P. canariensis*). There are several mineral springs on the island. From the nature of the ground only a small part is under cultivation. *Las Palmas* (population 12,572), the seat of the local Government, is a well-built and clean town on a small bay on the north coast, deriving its name from the numerous palm trees. It contains a handsome cathedral, a hospital, a college, several secularized convents, and an alameda or public walk. Its climate is more humid than that of Santa Cruz. Water is brought into the principal streets and squares by an aqueduct. The harbour, Puerto de la Luz, is defended by several *forts*, and affords good anchorage and shelter against all winds except the south-east. A British vice-consul resides here. In 1851 the cholera visited the island, and 9000 persons died, whilst not a single case occurred on any other island. *Telde*, the second place in the island, stands on a plain, surrounded by palm trees. At *Atalaya*, a short distance from Las Palmas, the making of earthenware vessels employ some hundreds of people, who inhabit holes made in the tufa.

Palma

PALMA (correctly, San Miguel de la Palma), 26 miles long, with an extreme breadth of 16 miles, lies 67 miles W.N.W. of Teneriffe. It is traversed in its longest direction (north to south) by a chain of mountains, the highest of which is 7900 feet above the sea. At the broadest part is a crater nine miles in diameter, known as the Caldera (*i.e.*, cauldron), from which, on its south-west side, runs a ravine to the sea. The bottom of the crater has an elevation above the sea of 2300 feet, and it is overhung by peaks that rise more than 5000 feet above it. Some of these peaks are covered with snow for several months in the year. Extensive woods, principally composed of chestnut and pine, lie on their flanks. Palma contains several mineral springs, but there is great want of fresh water. The only stream which is never dried up is that which issues from the Caldera. In 1677 an eruption, preceded by an earthquake, took place from a volcano at the southern extremity of the island, and much damage

was done by the ejected ashes, stones, and lava. The sugar-cane is grown on an elevated plain called Los Llanos. *Santa Cruz* on the eastern coast is the principal town (population 4400). Ribands and stockings are manufactured there from silk produced on the island. The anchorage is good. The cultivated soil is fertile, but the labouring classes are in a wretched condition, notwithstanding their industrious habits.

Lanzarote. LANZAROTE, the most easterly of the group, has a length of 31 miles and a breadth varying from 5 to 10 miles. It is naked and mountainous, bearing everywhere marks of its volcanic origin. Montaña Blanca, the highest point, attains a height of 2000 feet, and is cultivated to the summit. In 1730 the appearance of half the island was altered by a volcanic outburst. A violent earthquake preceded the catastrophe, by which nine villages were destroyed. In 1825 another volcanic eruption took place accompanied by earthquakes, and two hills were thrown up which still emit smoke. The port of Naos on the south-east of the island affords safe anchorage. It is protected by two forts. A short distance inland is the town of Arrecife (population 2700), where a British vice-consul resides. The climate is hot and dry. There is only a single spring of fresh water on the island, and that is in a position difficult of access. From the total failure of water the inhabitants were once compelled to abandon the island. Grain, wine (which is of superior quality), brandy, barilla, orchil, and raisins made from the muscatel grape are the principal articles of export. Dromedaries are used as beasts of burden. *Teguise* (population 1000), on the north-west coast, is the residence of the local authorities. A strait of about 6 miles in width separates Lanzarote from Fuerteventura.

Graciosa. GRACIOSA, a small uninhabited island, is divided from the north-eastern extremity of Lanzarote by a channel a mile in width, which affords the most capacious and only safe harbour for large ships at the Canaries; but basaltic cliffs, 1500 feet high, prevent intercourse with the inhabited part of Lanzarote. A few persons reside on the little island Allegranza, a mass of lava and cinders ejected at various times from a now extinct volcano, the crater of which has still a well-defined edge.

Fuerteventura. FUERTEVENTURA lies between Lanzarote and Grand Canary. It has a length of 52 miles, and an average width of 12 miles. Though less mountainous than the other islands, its aspect is barren. The springs of fresh water are only two, and they are confined to one valley. Lava streams and other signs of volcanic action abound, but there has been no igneous activity since the Spaniards took possession. At each of its extremities are high mountains, which send off branches along the coast so as to enclose a large arid plain. The highest peak reaches 2500 feet. In external appearance, climate, and productions this island greatly resembles Lanzarote. An interval of three years without rain has been known. The wine is bad. Barilla and orchil are largely exported. *Oliva*, with 970 inhabitants, is the largest town. A smaller place in the centre of the island named *Betancuria* is the residence of the authorities. *Cabras*, on the eastern coast (population 1000), is the chief port. Dromedaries are bred here.

Gomera lies 20 miles south-west of Teneriffe. Its greatest length is about 23 miles. The coast is precipitous and the interior mountainous, but it has the most wood and is the best watered of the group. The inhabitants are very poor. The palm trees produce excellent dates; and wine, brandy, orchil, raw silk, and dried fruits are sent to Teneriffe. Dromedaries are bred on Gomera in large numbers. *St Sebastian*, the chief town and a port, has 2240 inhabitants. Columbus resided here before sailing in search of the New World.

HIERRO, or *Ferro*, the most westerly and the smallest island of the group, is somewhat crescent-shaped. Its length is about 18 miles, its greatest breadth about 15 miles, and its circumference probably 50 miles. It lies 92 miles W.S.W. of Teneriffe. Its coast is bound by high steep rocks, which only admit of one harbour, but the interior is tolerably level. Its hill-tops in winter are sometimes wrapped in snow, which, however, does not lie long. Better and more abundant grass grows here than on any of the other islands. The island is exposed to westerly gales, which frequently commit great damage. Fountains of fresh water are few, but there is a sulphurous spring, with a temperature of 102° Fahr. The once celebrated and almost sacred Til tree, which was reputed to be always distilling water in great abundance from its leaves, no longer exists. Only a small part of the cultivable land is under tillage, the inhabitants being principally employed in pasturage. Wine, brandy, orchil, excellent dried figs, and sheep are sent to Teneriffe. At *Valverde*, the principal town, with 4640 inhabitants, the local authorities reside. Geographers were formerly in the habit of measuring all longitudes from Ferro, the most westerly land known to them. The longitude assigned at first has, however, turned out to be erroneous; and the so-called "Longitude of Ferro" does not coincide with the actual longitude of the island.

See Bethencourt, *The Canarian*, published by the Hakluyt Society in 1872; Von Buch, *Description des Iles Canaries*, 1803; Bory de Saint Vincent, *Les Iles Fortunées*, 1825; Fritsch, *Reisebilder von den Canarischen Inseln*, published as the 22d supplemental part to Petermann's *Mittheilungen*; C. Piazzi Smyth, *Teneriffe*, 1868. (J. Y. J.)

CANCALE, a seaport town of France, in the department of Ille-et-Vilaine, 10 miles E. of St Malo, on the bay of St Michael. A considerable trade is carried on in oysters, which are found in the bay in great numbers and of excellent quality. In 1758 the duke of Marlborough disembarked an army of 14,000 English here for the purpose of attacking St Malo, but retired without accomplishing anything. Population in 1872, 3814.

CANCAO, CANCAR, or KANG-KAO, otherwise known as Ponthiamus or Potai-mat, or in Chinese, Ha Thian, the capital of a small state in Western Cambodia, on the eastern side of the Gulf of Siam, at the mouth of the River Cancao or Klong Chanda; in 10° 14′ N. lat. and 104° 55′ E. long. The town was once a great centre of Cambodian trade, its port having been declared free by a man of Chinese origin, who took advantage of the civil troubles of Siam to effect his purpose. In 1717, however, the Siamese expelled the merchants who had flocked to the place; and though a considerable exportation of rice and salt is still maintained, the prosperity of the town has largely diminished. The harbour is shallow, though the river in general has a great depth of water. A canal gives communication with the Mekong River.

CANCER, or CARCINOMA (from *cancer*, or *καρκινος*, an eatihg ulcer), is the name given to a class of morbid growths or tumours which occur in man, and also in certain of the lower animals. The term is apt to be somewhat loosely employed, partly owing to the fact that there are not a few forms of diseased growth respecting which it is still a matter of debate whether they are to be regarded as cancerous or not; and in some measure also to the difficulty often experienced in recognizing true cancer particularly in its earlier stages.

The disease exists in various forms, which, although differing from each other in many points, have yet certain common characters to which they owe their special significance.

1. In structure such growths are composed of nucleated cells and free nuclei together with a milky fluid called

cancer juice, all contained within a more or less dense fibrous stroma or framework.

2. They have no well-defined limits, and they involve all textures in their vicinity, while they also tend to spread by the lymphatics and veins, and to cause similar growths in distant parts or organs called "secondary cancerous growths."

3. They are undergoing constant increase, and their progress is usually rapid.

4. Pain is a frequent symptom. When present it is generally of a severe and agonizing character, and together with the local effects of the disease and the resulting condition of ill health or "cachexia," hastens the fatal termination to which all cancerous growths tend.

5. When such growths are removed by the surgeon they are apt to return either at the same or at some other part.

The chief varieties of cancer are *Scirrhus* or hard cancer, *Encephaloid* or soft cancer, and *Epithelial cancer*.

Scirrhus is remarkable for its hardness, which is due to the large amount of its fibrous, and relatively small proportion of its cell elements. It is of comparatively slow growth, but it tends to spread and to ulcerate. Its most common seat by far is the female breast, though it sometimes affects internal organs.

Encephaloid is in structure the reverse of the last, its softness depending on the preponderance of its cell over its fibrous elements. Its appearance and consistence resemble brain substance (hence its name), and it is of such rapid growth as to have given rise to its being occasionally termed *acute cancer*. Its most frequent seats are internal organs or the limbs. Ulceration and hæmorrhage are common accompaniments of this form of cancer.

Epithelial cancer is largely composed of cells resembling the natural epithelium of the body. It occurs most frequently in those parts provided with epithelium, such as the skin and mucous membranes, or where those adjoin, as in the lips. This form of cancer does not spread so rapidly nor produce secondary growths in other organs to the same extent as the two other varieties, but it tends equally with them to involve the neighbouring lymphatic glands, and to recur after removal.

Various views are entertained, and much discussion has taken place respecting the causation of cancer, but little has as yet been satisfactorily ascertained on the point. By some the disease is held to be from the first an entirely local affection, due to some alteration in the nutrition of the part, irrespective of any condition of the system generally, but in course of time coming to assume a malignant form, and to infect the system secondarily. Others, on the contrary, maintain that a certain constitutional condition, either as regards the blood or some of the tissues of the body, must exist prior to the development of the disease to which it gives rise. A third view is that the concurrence of a constitutional and a local cause is necessary for the production of cancer. Without entering into an examination of these opinions, it appears evident that a constitutional element cannot be excluded in view of such well-known facts as a hereditary liability to cancer, and also of its occasional appearance in several parts of the body at one time.

The hereditary tendency in some persons to this disease has long been recognized by medical men; but its extent was not accurately ascertained till Sir James Paget affirmed, as the result of his observations, that in one out of every three cases of cancer a family history of the malady could be traced, and further, that even this probably does not represent the whole extent of the hereditary predisposition to cancer.

Cancer is essentially a disease of degeneracy, all statistics going to show its relatively great frequency after middle life; and the mortality, according to Dr Walshe, goes on increasing with each decade until the eightieth year. Cancer may, nevertheless, attack persons of any age, and instances of its occurrence are not unknown even among young children. It affects females to a much larger extent than males,—this, however, being fully explained by the greater liability of the female breast and of the uterus to the disease than any other organs of the body; for, apart from this, cancer is quite as common among men. It occurs equally among all ranks of life.

The commencement of a cancerous growth is frequently attributed to some local injury, as in the case of blows on the breast, or in the well-known instance of cancer of the lip following the irritation produced by smoking a short clay pipe. But it is only as exciting causes that the influence of such injuries can be admitted; and there must still remain, as necessary to account for the disease, some antecedent condition of the system which gives the particular direction to the form of morbid action in the part.

Cancer tends to advance steadily to a fatal termination, but its duration varies in different cases according to the part affected, and according to the variety of the disease. Soft cancer affecting important organs of the body often proves fatal in a few months, while, on the other hand, cases of hard or epithelial cancer may sometimes last for several years; but no precise limit can be assigned for any form of the disease. In some exceptionally rare instances cancerous growth may exist for a great length of time, and undergo a kind of spontaneous cure, or at least prolonged arrestment.

With respect to the treatment of cancer the only hope of success lies in the entire removal of the disease. This can obviously be only accomplished where the growth affects parts which are within reach of the surgeon. When in such cases the tumour is of recent formation, is limited in its extent, does not largely affect the neighbouring lymphatic glands, and has not as yet produced any marked deterioration of the general health, the surgeon is warranted in operating. Although it must be admitted that the results are generally disappointing from the intense tendency of the disease to recur sooner or later, yet the relief to suffering and the prolongation of life obtained are alone sufficient to justify operative interference when otherwise admissible, not to mention the fact that in some rare instances a cure has thus been achieved. Nor is the view of the constitutional and hereditary nature of cancer necessarily inconsistent with the adoption of such remedial measures,—since, from the analogy of other hereditary diseases, it is probable that these influences are more potent at certain times of life, and that by prompt treatment the period of special liability may be tided over, although the inherent tendency cannot be eradicated. When from the extent of the disease or its existence in internal organs no attempt at removal can be made, all that can be hoped for is the relief of suffering, and it is certain that even in such circumstances much may be done by appropriate medical treatment. It is painful to think how many of the unfortunate sufferers from this malady place themselves in the hands of ignorant persons who profess to be able to cure cancers, but whose violent remedies, if they do not actually destroy life, as has often been the case, only aggravate suffering and entail disappointment.

Cancer is known to occur in many of the lower animals, being probably most common among the domestic tribes, but it presents no special peculiarities as a disease beyond those already referred to. ([illegible])

CANCRIN, FRANZ LUDWIG VON ([illegible]), a German mineralogist and metallurgist, was born in [illegible] at Breitenbach. After acting as professor and [illegible] municipal offices in Hesse and at [illegible], he at

tracted the notice of the Empress Catherine of Russia, who made him director of the salt-mines of Staraja-Russa, councillor of the Imperial College, and, three years before his death, councillor of state. He is the author of a large number of works in German on mineralogy and metallurgy, of which the most important, the *Grundzüge der Berg- und Salzwerkskunde*, published at Frankfort in 13 vols., during the years 1773–1791, has been translated into several languages. He died in 1796.

CANDAHAR. See KANDAHAR.

CANDELABRUM, in Classical Antiquities, a stand for a lamp or lamps, usually of such a height as, when placed on the floor, to be serviceable to a person seated or reclining on a couch. The material varied according to the circumstances of the owner; only those of bronze have survived; but they are many. Generally the form consists of a heavy base resting on three spreading claws. From the base rises a tall usually fluted stem, branching out at the top into two or more arms from which the lamps were hung. On candelabra of this simple form the only place available for ornament was the top of the stem, on which a statuette or a group of figures could be placed; and it appears that very many of the small bronze statuettes now existing in museums had originally served this purpose. Or the lower part of the stem, immediately above the base, could be converted into a figure supporting the stem, as may be seen in several very beautiful examples in the British Museum. There was, however, no limit to the extent to which the original form might be departed from, as many of the candelabra from Pompeii show.

CANDESH, or KANDEISH. See KHANDESH.

CANDIA, the modern name of the island of CRETE (*q.v.*)

CANDIA, formerly the capital and still the most populous city of Crete, to which it has given its name (see CRETE), is situated on the northern shore somewhat nearer the eastern than the western end of the island, in 35° 20′ N. lat. and 25° 9′ E. long. It is still surrounded by its extensive Venetian fortifications; but they have fallen into disrepair, and a good part of the town is in a dilapidated condition, mainly from the effects of earthquakes. The principal buildings are the pasha's palace, the mosques, which are fourteen in number, the two Greek churches, the Armenian church, the Capuchin monastery, the bazaars, and the baths. The town is the seat of a Greek archbishop, and one of the churches ranks as a cathedral. The chief trade is in oil and soap, both of which are of excellent quality; 900 tuns of the former were exported in 1873, and of the latter 40,000 cwts. The coasting trade, which is of considerable importance, is mainly carried on in Turkish vessels. The manufacture of leather for home consumption is an extensive industry, and wine of good quality is produced in the neighbourhood. The which had grown almost inaccessible, was deepened apha Pasha between 1820 and 1840. It is formed most part by the ancient moles, and was never deep to admit the larger vessels even of the Venetians, ere accustomed to anchor in the port of the neigh- island of Standia. A short distance from St Gate there is a small village exclusively inhabited s, who number about seventy families. The popu- the town is estimated at from 15,000 to 18,000, ro-thirds being Turks. Candia, or as it is frequently Iegalo Castro (the Great Fortress), occupies the site ancient *Heracleion*, the seaport of *Gnossus*, and is own by that name to the Greek speaking population. ...ns of the mother city are situated at the distance of about two miles and a half to the S.E. at the village of Makri Teikos or Long Wall. Founded by the Saracens in the 9th century, Candia was fortified by the Genoese in the 12th, and was greatly extended and strengthened by the Venetians in the 13th, 14th, and 15th centuries. It was besieged by the Turks under the Vizier Achmet in 1667; and, in spite of a most heroic defence, in which the Venetians lost 30,000 in killed and wounded, it was forced to surrender in 1669. (Spratt's *Travels in Crete*, 1865.)

CANDIAC, JEAN LOUIS PIERRE ELIZABETH DE MONTCALM DE, a child of astonishing precocity, born at the Château de Candiac, in the diocese of Nîmes in France, in 1719. At four years of age he read Latin, either printed or in manuscript; and at six he understood Greek and Hebrew, had an astonishing acquaintance with arithmetic, history, geography, and heraldry, and had read many of the best authors. His extraordinary powers attracted the attention of the learned; and it was for his benefit that the typographic board was contrived by M. Dumas, who superintended his instruction. He died at Paris in 1726.

CANDLE, a cylindrical rod of solid fatty or waxy matters, enclosing a central fibrous wick, and designed for giving light.

The raw materials mostly used for candles are tallow and palm oil; they are also made from wax, cocoa-nut oil, paraffin, spermaceti, the mineral wax called *ozokerit*, &c. For ordinary tallow candles, the mutton or ox tallow, taken as soon as possible after separation from the carcase, is sorted, cut into pieces, and melted in a pan; the membranous matters, which are known as *graves* or *cracklings*, collect at the surface; and the liquid tallow, after being strained through a sieve and washed with boiling water, is ready for use. The candles are made either by dipping or by moulding.

The common tallow candles, however, are greatly inferior, both as regards illuminating power and absolute expense, to those now obtained from raw fats by processes based on the researches of some French chemists. The stearine or stearic acid industry, which is now of large proportions, originated in M. Chevreul's discovery that fats are composed of one or more inflammable fatty acids combined with a comparatively uninflammable base, glycerine. Thus, tallow or palm oil consists of palmitic, stearic, and oleic acids, with glycerine. An economical method of separating the acids and the glycerine was first discovered in 1831 by De Milly, who used lime for the purpose, in place of potash and soda, the substances adopted by Chevreul and Gay-Lussac in their patent of 1825. The factory established by De Milly and Motard near the *Barrière de l'Étoile*, in Paris, gave the "star candles" their name.

In this saponification by means of lime, the melted fat is stirred some hours with a mixture of lime (about 14 per cent. of the weight of the fat) and water. The lime combines with the acids to form a soap, and the glycerine, dissolved in the water, is then run off. Next, the lime soap is decomposed, under heat, by means of sulphuric acid, which unites with the lime, the fatty acids being set free. 100 parts of the fatty acids, at this stage, give on an average 45·9 parts of a mixture of stearic and palmitic acids. The acids are washed with water, and allowed to cool and solidify. They are then pressed in press bags, both in the cold state and with application of heat, to expel oleic acid, which is liquid. After further purification, they are ready to be made into "stearine candles."

Various other methods of saponification have come into practice. Thus it was found that the amount of lime in the foregoing process might be greatly reduced if the mixture were heated to a higher temperature with superheated steam. In another method, sulphuric acid is added to the fat, and the mixture is heated. The black mass produced is washed with boiling water till all the fatty acids are completely freed from sulphuric acid. Then they are distilled with the aid of superheated

steam, cooled and pressed. This process offers advantages in treatment of impure and refuse fats, but it involves some waste of fat. Distillation has been dispensed with in the simpler process of De Milly (who found that fat could be saponified with sulphuric acid without formation of tarry matter), and more recently in that of Bock. According to the latter, most neutral fats consist of small fat spherules, with thin albuminous skins. A little strong sulphuric acid introduced, under given conditions, has the effect of partly carbonizing the skins and liberating the neutral fat, which is then ready for decomposition by boiling with water in open vessels. The fatty acids obtained after decomposition (they are about 94 per cent. of the original fat) are of a dark colour, from the presence of portions of the carbonized skins. By suitable oxidation with acid, the colouring matters are rendered precipitable. The fatty acids are afterwards pressed. A method of saponification specially suitable for palm oil is that of heating the substance in a still to a temperature of 290° to 315° C., and passing a current of superheated steam through it. Saponification by water under high pressure seems to have been first observed by Faraday in 1823; and the process has been developed industrially by Tilghmann, Melsens, and others.

The wicks of candles are generally of cotton-yarn, and, to secure good steady combustion, they should be of uniform thickness, and free from knots or loose threads. The parallel threads of the wick are commonly twisted into a loose spiral. Plaited wicks were introduced by Cambacérès, his object being to do away with the necessity of snuffing. Through twisting of the plaited wick as it burns, the protruding end is kept just outside the flame, and consumed to ash by the surrounding air. In stearine candles, the combustibility is often aided by impregnating the wicks with a solution of boracic acid; a glass bead is formed at the top of the burning wick through the action of the acid on the constituents of the ash, and this by its weight turns the wick out of the flame. Another form of wick for stearine candles is prepared by first winding cotton-yarn round a wire. The covered rod is inserted in the mould, and after moulding is withdrawn from its covering, which remains as the wick. Machinery is now used in making various kinds of wick.

In the production of candles by dipping, the wicks are first arranged in pendant position on sticks on a frame corresponding in size to the dipping-trough, and each frame is suspended from one of a number of cross arms projecting from and jointed with an upright beam which turns on pivots. The workman turns these arms round, and as each frame comes over the dipping-trough, he presses the frame down, so that all the wicks are immersed in the tallow. This coats the wicks with one thin layer; the arms are then turned round, and each frame, as it successively arrives over the cistern, is treated the same way. The layer of tallow added in the dipping becomes consolidated before the turn comes for that set of candles to receive a second dip; and the arms are turned round and the candles dipped again and again, until all have acquired the requisite thickness and weight, which is known by a counterpoise fixed to the arm.

In the process of moulding, on the other hand, a number of slightly conical pewter moulds (ten to eighteen), finely-polished inside, are fixed by the larger extremity to a kind of trough, their taper ends projecting downwards. The wick is then fixed in the centre of the mould by being drawn through an aperture at the point of the mould which forms the upper end of the candle, and is retained in its place at the open extremity within the trough by means of a wire or other arrangement. The liquid material, being poured into the trough, fills all the moulds, and as soon as it is solidified, any redundance is removed and the candle drawn out of the mould by the end of the wick which has been held by the wire. *Moulding-machines* are in common use, in which as one set of candles is discharged from the moulds, the latter are, by the same movement, rewicked for the next process of filling. A reel of wick is connected with each mould. The discharged candles are held in a horizontal position, while a knife severs the wicks. Before receiving the fat, the moulds are slid on a railway into a hot closet to be heated. Each machine holds about 200 frames of moulds, and each frame contains 18 bobbins, each of which at first has 60 yards of cotton wick.

The *stearine* candles are made by moulding. A difficulty arose from the tendency of stearic acid to crystallize in large foliated crystals, the candles produced being thus irregular in structure and brittle. The remedy at first adopted was the addition of a little arsenious acid, but this proved detrimental to health. The method now employed is to mix 2 to 6 per cent. of white wax with the stearic acid when molten, or to add about 20 per cent. of paraffin.

Wax is a material not very suitable for moulding on account of its contraction in cooling and adhesion to the moulds. Several varieties of wax, besides that of bees, are used in candle-making. The wax is first submitted to a bleaching process; and the candles are generally made by ladling molten wax upon the wicks from a large basin over which they are suspended from an iron ring. When the proper thickness has been acquired, the candles are taken down and rolled on a marble slab, or wooden table, and are then cut and trimmed. Where wax candles are made by the hand, the wax, being kept soft in hot water, is applied bit by bit to the suspended wick. Presses have been contrived for making wax candles; they are of similar arrangement to those for making continuous lengths of lead and block-tin pipes. The wick is so directed that it is concentrically surrounded with soft wax when ejected from the spout of the cylinder of the press, thus forming a continuous candle, which is afterwards cut up into lengths. Wax tapers of various thickness are produced by drawing the uncut wick through molten wax in a pan, then through a draw iron provided with somewhat conical apertures, arranged like those for wire-drawing, in the side of the vessel. The waxed wick is wound very slowly on a drum, the wax having time to solidify in its passage. The process may be repeated several times with drawing irons of increasing aperture.

Paraffin, now largely made into candles, is obtained from native petroleum (Rangoon oil), or from the products of dry distillation of peat, brown coal, Boghead mineral, lignite, bituminous schist, or ozokerit. The paraffin of candles is generally a mixture of several paraffins having different melting points. A little stearic acid (5 to 15 per cent.) is usually added, in order to make the candles more rigid, and in some instances to raise the temperature of fusion: it also facilitates colouring. The candles are moulded much in the same way as stearine candles. The molten paraffin, however, is solidified suddenly by immersion of the warm moulds in cold water, the paraffin being thus prevented from becoming crystalline and opaque. For black paraffin candles the paraffin is heated with anacardium shells, the resin of which is dissolved by it.

The mineral wax or paraffin known as *ozokerit* is found in the Carpathian Mountains, Galicia, Bohemia, and elsewhere. At the low temperature of 66° C. it becomes fluid, and other less fusible substances can then be added. Dr Letheby has observed that the light of 754 [illegible] candles equals that of 891 paraffin, or 1150 wax candles. *Spermaceti* is the solid matter obtained from the oil of the sperm whale by filtration. In further preparation for candles it is hardened and whitened by pressure, and refined by a weak

alkaline ley. A little wax or paraffin is added to prevent crystallization. Sperm candles have a high illuminating power, and notwithstanding their costliness, a considerable trade is done in them. The well-known *composite* candles are made of a mixture of palm-acid and the stearine of cocoa-nut oil in various proportions. *Belmont sperm* is made of hot-pressed distilled palm-acid; *Belmont wax* of the same mineral tinged with gamboge. *Night lights* are short thick cylinders of fat, with a very thin wick, calculated usually to burn from six to ten hours. In making them, the melted fat is poured into shallow moulds having movable bottoms, with a projecting wire which moulds a narrow tube for the wick. By pressing up the bottom the cylinders of fat are ejected; a wax-covered wick supported on a small piece of tin is afterwards inserted, and is cemented at the bottom part by pressing the night light on a warm porcelain slab. *Child's night lights* are made in paper cases of the nature of pill boxes, having a hole in the bottom through which the tin-supported and waxed wick has been inserted.

A candle is a simple but ingenious contrivance for supplying a flame with as much melted material as it can consume without smoking. If the thickness of the candle be properly adapted to that of the wick, the fatty matter immediately below the flame is melted, so that a cup-like reservoir is produced, always properly filled for feeding the flame. The fibres of the wick act as a congeries of capillary tubes which convey the fluid fat into the flame, where, being exposed to a high temperature and sheltered from the air by the outer shell of flame, it becomes subjected to a dry distillation. The inflammable vapour thus produced rises, and by constant combustion diminishes in quantity and consequently in diameter, until at length it entirely disappears in a point. A current of air from below is produced by the heat of the flame; the oxygen of the air, aided by the high temperature, decomposes the inflammable vapour of the fat into hydrogen and carbon, and unites with these to form water and carbonic acid.

The interior dark part of a candle or other flame contains unignited inflammable vapour which will not of itself support combustion; it may be drawn off with a glass tube and ignited at a distance. According to Frankland, the luminosity of an ordinary candle, lamp, or gas flame is due, not, as commonly supposed, to the separation of solid particles of carbon, but to that of very dense hydrocarbons, which produce the same effect as the vapours of arsenic and phosphorus in their respective flames.

The excise duty of ½d. per lb. on tallow candles, and 3½d. per lb. on wax and spermaceti candles, was repealed in 1832. (A. B. M.)

CANDLEMAS, a church festival, held on the 2d of February, which has in Scotland been chosen as one of the four term-days. The festival commemorates the purification of the Virgin; and the observances to which it owes its name, viz., the lighting of candles, and, in the Roman Catholic Church, the consecration of the candles which are to be used during the year for ecclesiastical purposes, are said to have an emblematical reference to the prophecy of Simeon that the child Jesus should become "a light to lighten the Gentiles." The institution of this feast dates probably from the reign of Justinian, and the year 542 is sometimes fixed upon as that of its first celebration. It is supposed to have grown out of the heathen festivals held in this month,—a view which is supported by the following considerations:—(1), The word February (connected with *februare*) denotes purification; (2), in this month the purification of the people took place; (3), the rites of the Lupercalia, which were celebrated on the 15th, included the lighting of candles, in allusion to those used by Ceres in her search for Proserpine; and (4), the origin of other Christian feasts appears to have been similar.

CANDLESTICK, in the earlier meaning of the word, was the name applied to any form of support on which lights, whether candles or lamps, were fixed; and so it happens that what would now be called a candelabrum is still sometimes spoken of from tradition as a candlestick, *e.g.*, as when Moses was commanded to make a candlestick for the tabernacle, of hammered gold, a talent in weight, and consisting of a base with a shaft rising out of it and six arms, and with seven lamps supported on the summits of the six arms and central shaft. When Solomon built the temple, he placed in it ten golden candlesticks, five on the north and five on the south side of the Holy Place; but after the Babylonish captivity, the golden candlestick was again placed in the temple, as it had been before in the tabernacle by Moses. On the destruction of Jerusalem by Titus, it was carried with other spoils to Rome. Representations of the seven-branched candlestick, as it is called, occur on the arch of Titus at Rome, and on antiquities found in the Catacombs at Rome. The primitive form of candlestick was a torch made of slips of bark, vine tendrils, or wood, dipped in wax or tallow, tied together and held in the hand by the lower end, such as are frequently figured on ancient painted vases. The next step was to attach to them a cup (*discus*) to catch the dripping wax or tallow. See CANDELABRUM.

CANDLISH, ROBERT SMITH, D.D. (1806–1873), an eminent Scottish clergyman, was born at Edinburgh on the 23d March 1806. His father, who was a teacher of medicine, having died a few weeks after his birth, the widow and family removed to Glasgow, where young Candlish was brought up and educated. In 1818 he entered the University of Glasgow, and after a curriculum of five sessions, during which he carried off many honours, he duly graduated M.A. Entering immediately on his professional studies, he passed during the years 1823–26 through the prescribed course at the divinity hall, then presided over by Dr Stevenson MacGill. While carrying on his studies he had been largely occupied, according to the common Scotch practice, with private teaching, and on leaving the divinity hall he accompanied a pupil as private tutor to Eton. On the termination of this engagement in 1829, he entered upon his own proper work, having been licensed to preach during the summer vacation of the previous year. He was employed for two years as assistant to the minister of the parish of St Andrews, Glasgow, and he subsequently occupied a similar situation for about the same period in the parish of Bonhill, Dumbartonshire. In each case the entire duties of the charge devolved upon him, and he fulfilled them with characteristic energy and zeal. It was not until 1834, after he had offered himself for service in Canada, in the belief that he was not to find a sphere of labour at home, that he obtained a settled charge as minister of the important parish of St George's, Edinburgh. Here he at once took the place he so long held as one of the ablest preachers in Scotland. Destitute of natural oratorical gifts, and somewhat ungainly in his manner, he attracted and even rivetted the attention of his audience by a rare combination of intellectual keenness, emotional fervour, spiritual insight, and power of dramatic representation of character and life. His theology was that of the Scottish Calvinistic school, but he combined with the narrowness that springs from strong conviction the breadth that springs from tender sympathy. With such qualities it was natural that he should gather round him one of the largest and most intelligent congregations in the Scottish metropolis.

From the very commencement of his ministry in Edinburgh, Candlish took the deepest interest in ecclesias-

tical questions, and he soon became involved as one of the chief actors in the struggle which was then agitating the church. His first Assembly speech, delivered in 1839, placed him at once among the leaders of the party that afterwards formed the Free Church, and his influence in bringing about what is known as the Disruption was inferior only to that of Chalmers. As a debater he had powers of the highest order, which would have won for him a foremost place in any deliberative assembly. Great as was his popularity as a preacher, it was in the ecclesiastical arena that his ability chiefly showed itself, and probably no other single man had from first to last so large a share in shaping the constitution and guiding the policy of the Free Church. He was actively engaged at one time or other in nearly all the various schemes of the church, but special mention should be made of his services in the Education Committee, of which he was convener from 1846 to 1863, and in the unsuccessful negotiations for union among the non-established Presbyterian denominations of Scotland, which were carried on during the years 1863–73. In the Assembly of 1861 he filled the moderator's chair.

As a theologian the position of Candlish was perhaps inferior to that which he held as a preacher and ecclesiastic, but it was not inconsiderable. So early as 1841 his reputation in this department was sufficient to secure for him the nomination to the newly-founded chair of Biblical Criticism in the University of Edinburgh. The appointment was, however, not ratified by the Home Secretary in consequence of a representation made in the House of Lords, by the earl of Aberdeen, that Candlish had set himself in opposition to the law of the land by preaching in the parish of Huntly in spite of an interdict from the Court of Session. By a somewhat curious coincidence a second appointment to a professorship was also nullified, though in this case by his own act, and after a few months' tenure of the office. In 1847 Candlish, who had received the degree of D.D. from Princeton, New Jersey, in 1841, was chosen by the Assembly of the Free Church to succeed Chalmers in the chair of divinity in the New College, Edinburgh. After partially fulfilling the duties of the office for one session, he was led to resume the charge of St George's, the clergyman who had been chosen by the congregation as his successor having died before entering on his work. In 1862 he was again connected with the New College, being appointed principal in succession to Cunningham, with the understanding that he should still retain his position as minister of St George's. Some months before this he had obtained the assistance of a colleague in his pastoral work, but he continued to preach, with one or two intervals of somewhat protracted illness, until within a short time of his death, which occurred on the 19th October 1873.

Though his greatest power was not displayed through the press, Candlish made a number of somewhat important contributions to theological literature. In 1842 he published the first volume of his *Contributions towards the Exposition of the Book of Genesis*, a work which was completed in three volumes several years later. In 1854 he delivered, in Exeter Hall, London, a lecture on the *Theological Essays* of the Rev. F. D. Maurice, which he afterwards published, along with a fuller examination of the doctrine of the essays. A treatise entitled *The Atonement; its Reality, Completeness, and Extent* (1861) was based upon a smaller work which first appeared in 1845. In 1864 he delivered the first series of Cunningham lectures, taking for his subject *The Fatherhood of God*. Published immediately afterwards, the lectures excited considerable discussion on account of the peculiar views they represented. Further illustrations of these views were given in two works published about the same time as the lectures, one a treatise *On the Sonship and Brotherhood of Believers*, and the other an exposition of the first epistle of St John. Among his other works were *Life in a Risen Saviour*; *Scripture Characters*; *Reason and Revelation*; and *The Christian's Sacrifice and Service of Praise*. A posthumous volume of sermons with a short prefatory biographical sketch appeared in 1874.

CANDOLLE, AUGUSTIN PYRAME DE. See DE CANDOLLE.

CANE, a name applied to many plants which are possessed of long, slender, reed-like stalks or stems, as, for example, the sugar-cane, the bamboo-cane, or the reed cane. From the use as walking-sticks to which many of these plants have been applied, the name cane is improperly given to sticks irrespective of the source from which they are derived. Properly it should be restricted to a peculiar class of palms, known as ratans, included under the two closely allied genera *Calamus* and *Dæmonorops*, of which there are a large number of species. The plants are found widely extended throughout the islands of the Indian Archipelago, the Malay Peninsula, China, India, and Ceylon; and examples have also been found in Australia and Africa. They were described by the learned Rumphius, under the name of Palmijunci, as inhabitants of dense forests into which the rays of the sun scarce can penetrate, where they form spiny bushes, obstructing the passage through the jungle. They rise to the top of the highest trees and fall again so as to resemble a great length of cable, adorned, however, with the most beautiful leaves, pinnated or terminating in graceful tendrils. The plants creep or trail along to an enormous length, sometimes, it is said, reaching 500 feet. In the Paris exhibition of 1855 two examples of *Calamus verus*, measuring respectively 270 and 230 feet, were exhibited. The stem in few cases exceeds 1 inch in diameter, and it is mostly of much smaller dimensions. When growing it is sheathed in a base of numerous leaves, which the natives, in preparing the canes for the market, strip off by pulling the cut plant through a notch made in a tree. The canes always present distinct rings at the junction of the sheathing leaves with the stem. They assume a yellow colour as they dry; and those imported from Calcutta have a glossy surface, while the produce of the Eastern Archipelago presents a dull exterior.

Canes, on account of their lightness, length, strength, and flexibility, are used for a great variety of purposes by the inhabitants of the countries in which they grow. Split into thin strips they are twisted to form ropes and ships' cables, an application mentioned by Captain Dampier in his *Voyages*. A more important application, however, is for basket-work, and for making chairs, couches, pillows, &c., as the great strength and durability of thin and easily-prepared strips admit of such articles being made of

them efficient substitutes for whalebone. The walking-stick "canes" of commerce include a great many varieties, some of which, however, are not the produce of trailing palms. The well-known Malacca canes are obtained from *Calamus Scipionum*, the stems of which are much stouter than is the case with the average species of *Calamus*.

CANEA, or KHANIA, the principal seaport and since 1841 the capital of Crete, is finely situated on the northern coast of the island, about 25 miles from its western extremity, on the isthmus of the Akrotiri peninsula, which lies between the Bay of Canea and the Bay of Suda. Its latitude is 35° 31′ N., and its longitude 24° 1′ E. Surrounded by a massive Venetian wall, it forms a closely-built, irregular, and overcrowded town, though of late years a few of its streets have been widened. The ordinary houses are of wood; but the more important buildings are of more solid materials. The Turks have a number of mosques; there are Greek churches and a Jewish synagogue; an old Venetian structure serves as a military hospital; and the prison is of substantial construction. The town is the seat of a Greek bishop, who is suffragan to the metropolitan at Candia; and it is the official residence of the European consuls. The harbour, formed by an ancient transverse mole nearly 1200 feet long, and protected by a lighthouse and a fort, would admit vessels of considerable tonnage; but it has been allowed to silt up until it shoals off from 24 feet to 10 or even 8, so that large vessels have to anchor about four or five miles out. The principal articles of trade are oil and soap, of which there were exported, in 1874, 530 tuns and 50,000 cwts. respectively. A few small ships are built in the port, and there is a pretty extensive manufacture of leather. The fosse is laid out in vegetable gardens; public gardens have been constructed outside the walls; and artesian wells have been bored by the Government. To the east of the town a large Arab village has grown up, inhabited for the most part by natives of Egypt and Cyrenaica, who act as boatmen, porters, and servants, and number from 2000 to 3000; while about a mile off on the rising ground is the village of Khalepa, where the consuls and merchants reside. The population of the town is estimated at 12,000. Canea probably occupies the site of the ancient Cydonia, a city of very early foundation and no small importance. During the Venetian rule it was one of the strongest cities in the island, but it fell into the hands of the Turks in 1646, several years before the capture of Candia. In 1856 it suffered from an earthquake. The neighbouring plain is famous for its fruitfulness, and the quince is said to derive its name *Cydonia* from the town.

CANEPHORI was the title given to the girls who at Athens were annually selected from noble families to walk in the procession at the Panathenaic and apparently also at other festivals, carrying on their heads baskets containing the implements and apparatus necessary for a sacrifice. The gracefulness of the attitude which may be seen in the figures of Canephori on the frieze of the Parthenon in the British Museum, is known to have suggested itself as a subject for sculpture to Polycletus and Scopas. This type of statue also came to be used in architecture to support light entablatures, in which case they are sometimes identified with Caryatides.

CANGA-ARGUELLES, JOSÉ, Spanish statesman, was born in 1770, and died in 1843. He took an active part in the Spanish resistance to Napoleon, in a civil capacity, and was an energetic member of the Cortes of 1812. On the return of the Bourbon line in 1814, Canga-Arguelles was sent into exile in the province of Valencia. On the restoration in 1820 of the constitution of 1812, he was appointed minister of finance. He continued at this post till the spring of 1821, distinguishing himself by the zeal and ability with which he sought to reform the finances of Spain. It was high time; for the annual deficit was greater than the entire revenue itself, and landed and other property was, to an unheard-of extent, monopolized by the priests. The measures he proposed had been only partially enforced, when the action of the king with regard to the ministry, of which he was a member, obliged him to resign. Thereafter, as a member of the Moderate Liberal party, Canga-Arguelles advocated constitutional government and financial reform, till the overthrow of the constitution in 1823, when he fled to England. He did not return to Spain till 1829, and did not again appear in public life, being appointed keeper of the archives at Simancas. He is the author of three works:—*Elementos de la Ciencia de Hacienda* (Elements of the Science of Finance), London, 1825; *Diccionario de Hacienda* (Dictionary of Finance), London, 1827; and *Observaciones sobre la guerra de la Peninsula* (Observations on the Peninsular War), in which he endeavoured to show that his countrymen had taken a far more effective part in the national struggle against the French than English historians were willing to admit.

CANGIAGI, or CAMBIASO, LUIGI (1527–1585), a distinguished painter, was born at Genoa in 1527, and died at the Escorial in 1585. He received his first lessons in the art of painting from his father, and completed his education at Rome, where he studied with particular care the masterpieces of Michelangelo. At a very early age he had gained a high reputation as an artist, and in 1583 he was invited to Spain by Philip II., who desired his assistance in the decoration of the Escorial. He painted the ceiling of the choir, representing the Assemblage of the Blessed. It is considered his best work. Among his other productions which were highly esteemed were the Rape of the Sabine Women, the Sleeping Cupid, and Judith. Most of his paintings are in Genoa and Spain; the Sleeping Cupid is in the royal collection at Paris.

CANICATTI, a town of Sicily, in the province of Girgenti, which dates, it is believed, from the Saracenic occupation. It is well built and finely situated on the slope of a hill. The vine, orange, olive, and almond grow abundantly in the neighbourhood, and the inhabitants devote themselves chiefly to agricultural pursuits. Population, 20,908.

CANINA, LUIGI (1793–1856), an Italian archæologist and architect, was born at Casale in Piedmont. He became professor of architecture at Turin, and his most important works were the excavation of Tusculum in 1829, and of the Appian Way in 1848. He is the author of a great number of works on archæology and architecture, of which several were published in a most magnificent and costly form by his patroness, the queen of Sardinia. Of these may be mentioned *L'Architettura Romana*, 1830; *L'Architettura Greca*, 1833; *Descrizione storica del foro Romano e sue adjacenze*, 1834; *Descrizione dell' antico Tusculo*, 1841; *Sull' Architettura più propria dei tempi cristiani*, 1843.

CANINI, GIOVANNI AGNOLO (1617–1666), a designer and engraver, born at Rome in 1617. He was a pupil of Domenichino, and afterwards of Barbalunga. He painted some altarpieces at Rome, including two admired pictures for the church of San Martino a' Monti, representing the Martyrdom of St Stephen and of St Bartholomew. His painting aimed at general effect, not at precision of detail. Having accompanied Cardinal Chigi to France, he was encouraged by the minister Colbert to carry into execution his project of designing, from medals, antique gems, and similar sources, a series of portraits of the most illustrious characters of antiquity, accompanied with memoirs; but shortly after the commencement of the undertaking Canini died at Rome, in 1666. The work, however, was prosecuted by his brother Marcantonio, who, with the assistance of Picard and Valet, completed and published it in

1699, under the title of *Iconografia di Gio. Ag. Canini*. It contains 150 engravings. A reprint in Italian and French appeared at Amsterdam in 1731.

CANITZ, FRIEDRICH RODOLPH LUDWIG, BARON VON (1654–1699), a German poet and politician of noble family, was born at Berlin in 1654. He attended the universities of Leyden and Leipsic, and travelled in England, France, and Italy. In 1680 he became councillor of legation, and Frederick I. made him councillor of state, privy councillor, baron of the empire, and plenipotentiary at the Hague, all which positions he appears to have filled with credit. His reputation is, however, founded upon his verse. He believed that a great reform might be effected in German literature by the introduction of the rules of French taste; and, consequently, he became an imitator of Boileau, and through him of Horace,—the polished grace of whose verse he attained in some measure, though he does not always avoid turgidity and bombast.

CANNÆ, in Ancient Geography, a town of Apulia, on the River Aufidus, 6 miles from its mouth. It is famous for a terrible defeat which the Romans received there from the Carthaginians under Hannibal, 216 B.C. A great diversity of opinion has prevailed as to the exact spot on which the battle was fought, whether, as has been the general belief, on the south side of the river, or on the north bank, as is maintained by the best authorities, including Niebuhr, Swinburne, &c. The site of the town, which continued to exist at least till the 13th century, is still marked by ancient ruins, among which the most important are those of an aqueduct, an amphitheatre, and a triumphal arch. In a neighbouring rock are several large sepulchral excavations, in which vases and paintings have been discovered.

CANNES, a seaport of France, in the department of Alpes-Maritimes, on the Mediterranean, 15 miles S.W. of Nice and 25 miles N.E. of Draguignan, in 43° 34′ N. lat. and 7° 0′ E. long. It enjoys a southern exposure on a seaward slope, and is defended from the northern winds by ranges of hills. Previous to 1831, when it first attracted the attention of Lord Brougham, it mainly consisted of the old quarter (named Sucquet), and had little to show except an ancient castle, and a church on the top of Mont Chevalier, dedicated in 1603 to Nôtre Dame d'Espérance; but since that period it has become a large and important town, and one of the most fashionable winter resorts in the south of France, much frequented by English visitors. The neighbourhood is thickly studded with villas, which are solidly built of a stone so soft that it is sawn and not hewn. There is an excellent quay, and a beautiful promenade runs along the beach; and numerous sheltered roads stretch up the valleys amidst groves of olive trees. On the top of the hill behind the town are a Roman Catholic and a Protestant cemetery. In the most prominent part of the latter is the grave of Lord Brougham, distinguished by a massive stone cross standing on a double basement, with the simple inscription—"Henricus Brougham, Natus MDCCLXXVIII., Decessit MDCCCLXVIII.;" and in the immediate vicinity lies James, fourth duke of Montrose, who died December 1874. The country around is very beautiful and highly fertile; orange and lemon trees are cultivated like peach-trees in England, while olives, almonds, figs, peaches, grapes, and other fruits are grown in abundance, and, along with the produce of the fisheries, form the chief exports of the town. Essences of various kinds are manufactured, and flowers are extensively cultivated for the perfumers. The climate of Cannes has been the subject of a considerable variety of opinion,—the preponderance being, however, in its favour. According to Dr De Valcourt, it is remarkable by reason of the elevation and regularity of the temperature during the height of the day, the clearness of the atmosphere and abundance of light, the rarity of rain and the absence of fogs. The following are a few of his numerous observations of winter temperature, given in degrees Fahr.:—

	1865-1867.		1872-1873.	
	Maxima.	Minima.	Maxima.	Minima.
November.	72 to 56	56 to 34	67 to 47	59 to 34
December.	69 ,, 52	56 ,, 34	60 ,, 47	44 ,, 25
January.	65 ,, 47	50 ,, 27	62 ,, 50	50 ,, 34
February.	65 ,, 56	53 ,, 38	69 ,, 52	50 ,, 39
March.	71 ,, 49	54 ,, 38	69 ,, 56	54 ,, 39
April.	76 ,, 68	58 ,, 39	75 ,, 57	58 ,, 35

Cannes is a place of great antiquity, but its earlier history is very obscure. It was twice destroyed by the Saracens in the 8th and the 10th centuries; but it was afterwards repeopled by a colony from Genoa. In 1815 Napoleon landed in the vicinity after his escape from Elba; and opposite the town is the island of St Marguerite (one of the Lerins), in the citadel of which the Man with the Iron Mask was confined from 1686 to 1698, and which has acquired a recent notoriety as the prison whence Marshal Bazaine escaped in August 1874. Population of the town in 1872, 9618.

See De Valcourt's *Cannes and its Climate*, London, 1873, and *Climatologie des Stations Hivernales du Midi de la France*, Paris, 1865.

CANNIBALISM, the eating of human flesh by men. This practice has existed from the most ancient times, and has given rise to descriptive terms such as Gr. ἀνθρωποφάγος (Lat. *anthropophagus*), Anglo-Sax. *man-æta*, Eng. *man-eater*. Since the discovery of the New World, the name of the *Caribs* of the West India Islands, recorded by Columbus under the Latinized forms *Canibales* or *Caribales*, has come into popular use as a generic term for man-eaters, *cannibals*.

*Man being by nature carnivorous as well as frugivor*ous, and human flesh being not unfit for human food, the question first arises why mankind generally have not only avoided it, but have looked with horror on exceptional individuals and races addicted to cannibalism. It is evident on consideration that both emotional and religious motives must have contributed to bring about this prevailing state of mind. Simple association of thoughts causes the remains of a dead kinsman or friend to be treated with respect and tenderness, as may be seen from the conduct of some of the rudest races. Acting in another way, the same ideal association attaches the horror of death to anything connected with the dead, so that many tribes will avoid the mention of a dead man's name, and will even abandon his hut, and destroy the furniture he has used; this sentiment must tend to preserve the corpse from violation. Moreover, the religious doctrine that the soul outlives the body,

for storing as well as from their reckless improvidence, should in severe climates be often driven to this extremity. For example, it is known that the miserable natives of Tierra del Fuego, when starving in winter, would throttle and devour the oldest woman of the party; when asked why they did not rather kill their dogs, they replied, "Dog catch otters!" (Fitzroy, *Voy. of Adventure and Beagle*, vol. ii. p. 183). For accounts of cannibalism and murder under stress of hunger in Australia see Salvado, *Memorie dell' Australia*, p. 240; Waitz, *Anthropologie der Naturvölker*, vol. vi. p. 749; among American tribes, Bancroft, *Native Races of Pacific States*, vol. i. p. 120; Back, *Exp. to Great Fish River*, p. 227; Waitz, vol. iii. p. 89; in Polynesia, Ellis, *Polynesian Researches*, vol. i. p. 359; Martin, *Mariner's Tonga Islands*, vol. i. p. 116.

II. *Fury* or *Bravado.*—The North American Indian phrases as to eating the flesh and drinking the blood of their enemies are not to be taken as mere metaphor, but as referring to acts really done. There is even an Iroquois legend of a dialogue between the Manitu (Great Spirit) and a warrior who defends the eating of slain enemies as satisfying at once hunger and revenge (Crèvecœur, *Journey in Pennsylvania*; Klemm, *Allgemeine Culturgeschichte*, vol. ii. p. 28). For actual details of this ferocious custom see Schoolcraft, *Indian Tribes*, vol. iii. p. 242; Hennepin, vol. ii. p. 159; J. G. Müller, *Amerikanische Urreligionen*, p. 145; Waitz, vol. iii. p. 159. Among the Polynesians, there is similar evidence of warriors devouring the flesh and drinking the blood of the slain enemy, where the purpose seems clearly that of inspiring terror and gratifying vengeance. (See Ellis, *Polynesian Researches*, vol. i. p. 309; Turner, *Polynesia*, p. 194; Waitz, vol. vi. p. 158.)

III. *Morbid Affection.*—Cases of the dead being devoured by relatives and friends (especially children by parents) from a sentiment of affection are recorded among low savage tribes, see Spix and Martius, *Reise in Brasilien*, vol. ii. p. 692; Angas, *Savage Life in Australia, &c.*, vol. i. p. 73; Howitt, *Impressions of Australia*, p. 134; Gerland, *Aussterben der Naturvölker*, p. 66. Such accounts are not, however, numerous, and sometimes, at least, may properly belong to other classes. The most remarkable is the often-quoted passage of Herodotus (iv. 26), describing the funeral feasts of the Issedones of Central Asia, where the relatives ate the body of the deceased with other meat, the skull being set in gold and preserved; these were sacred rites done in honour of the dead. As lately as the 13th century, William of Ruysbruck was told that the people of Tibet had till recently kept up this custom of eating their deceased parents, and still used their skulls as drinking-cups (Rubruquis in *Pinkerton's Coll. of Voyages*, vol. vii. p. 54).

IV. *Magic.*—Few notions belonging to primitive savage magic are more intelligible or more widely spread than the belief that the qualities of any animal eaten will pass into the eater. This motive naturally leads to cannibalism (see Stanbridge, in *Trans. Ethnological Soc.*, vol. i. p. 289), especially in war, where the conqueror eats part of the slain enemy with the avowed purpose of making himself brave. This idea is found among the natives of Australia (see Macgillivray, *Voyage of Rattlesnake*, vol. i. p. 152, vol. ii. p. 6), and not less distinctly in New Zealand (Ellis, vol. i. p. 358); among the North American Indians, when warriors would devour the flesh of a brave enemy, and particularly the heart as the seat of courage (Keating, *Long's Expedition*, vol. i. p. 102); also in Ashantee (J. L. Wilson, *Western Africa*, p. 168). An English merchant in Shanghai, during the Taeping siege, met his Chinese servant carrying the heart of a rebel, which he was taking home to eat to make him brave (Tylor, *Early History of Mankind*, p. 133). The imagined value of human flesh in giving magical powers to the eater is known to the savage world both in Australia and America (Eyre, *Central Australia*, vol. ii. pp. 255, 329; Angas, vol. i. p. 123; Keating, vol. i. p. 103; Waitz, vol. iii. p. 159, vol. vi. p. 748). This idea even holds a place in the more cultured magical traditions of Asiatic and European nations (see Gerland, p. 66; Schaafhausen, in *Archiv für Anthropologie*, vol. iv. p. 247).

V. *Religion.*—One of the strongest reasons for considering anthropophagy as having widely prevailed in prehistoric ages is the fact of its being deeply ingrained in savage and barbaric religions, whose gods are so often looked upon as delighting in human flesh and blood. The flesh of sacrificed human victims may even serve to provide cannibal feasts. The understood meaning of these rites may be either that the bodies of the victims are vicariously consumed by the worshippers, or that the gods themselves feed on the spirits of the slain men, their bodies being left to the priests and people. Thus in Fiji, "of the great offerings of food, native belief apportions merely the *soul* thereof to the gods, who are described as being enormous eaters; the substance is consumed by the worshippers. Cannibalism is a part of the Fijian religion, and the gods are described as delighting in human flesh" (T. Williams, *Fiji and the Fijians*, vol. i. p. 231). In Mexico, the anthropophagy which prevailed was distinctly religious in its origin and professed purpose. That the primary meaning of the human sacrifice was to present victims to their deities is shown by the manner in which the sacrificing priest, who tore out the heart, offered it to the sun, and afterwards went through ceremonies of feeding the idol with the heart and blood. It was the Aztec worship of the war-god Huitzilopochtli which brought on the enormous prevalence of sacrifices of prisoners; to obtain supplies of such captives became a motive for frequent wars; and it was the limbs of these victims which were eaten in the sacrificial feasts that formed part of the festivals. (For particulars and authorities see Prescott, *Conquest of Mexico*; Bancroft, vol. ii.; Waitz, vol. iv.) In Africa, also, cannibalism has in some cases evidently a sacrificial character (see Lander, *Records*, vol. ii. p. 250; T. J. Hutchinson, *Ten Years among Ethiopians*, p. 62, &c.)

VI. *Habit.*—The extent to which anthropophagy has been carried among some nations is, no doubt, mainly due to the indulgence of the appetite once aroused. In such cases this reason is openly avowed, or some earlier motive remains rather in pretext than in reality, or the practice is justified on the ground of ancestral custom. It seems, for instance, that the cannibal feasts of old Mexico had become in themselves acceptable to the people, and that we must refer the sickening horrors of Fijian anthropophagy more to sensual gratification than to any religious motive. Among conspicuous cannibal races may be mentioned the semi-civilized Battas of Sumatra, whose original instigation to eating their enemies may have been warlike ferocity, but who are described as treating human flesh as a delicacy, and devouring not only war-captives but criminals, slaves, and, according to one story, their aged kinsfolk (Junghuhn, *Batta-länder*; Marsden, *Hist. of Sumatra*, p. 390; see also Wuttke, *Geschichte des Heidenthums*, vol. i. p. 172; Friedmann in *Zeitschrift für Ethnologie*, 1871, p. 313). Cannibalism assumes its most repulsive form where human flesh is made an ordinary article of food like other meat. This state of things is not only mentioned in past times in descriptions of West Africa, where human flesh was even sold in the market (see Pigafetta, *Regnum Congo*, in De Bry; Wuttke, vol. i. p. 171), but still continues among the Monbuttu of Central Africa, whose wars with neighbouring tribes are carried on for the purpose of obtaining human flesh, the bodies of the slain being dried for

transport, while the living prisoners are driven off like cattle (Schweinfurth, *Heart of Africa*, and in *Zeitschrift für Ethnologie*, vol. v. p. 9). Where cannibalism for its own sake becomes popular among a warlike people, its effect in thinning population, and even in exterminating weak tribes, becomes perceptible. This subject has been investigated by Gerland (*Aussterben der Naturvölker*, p. 61).

As to the history of anthropophagy, the most interesting question is whether at any early period it was ever a general habit of the human race. This has been debated on the evidence of prehistoric human remains (see Schaaf-hausen, *ubi supra*, p. 264; *Proceedings* of Congresses of Pre-historic Archæology, Paris and Copenhagen. It has been well argued that had the men of the quaternary period been cannibals, we should find the bones generally cracked for the marrow like those of beasts, which is not the case (Le Hon, *L'Homme Fossile*, p. 68); also that, as regards the ancient people of the shell-mounds, had they eaten their own species they would have thrown the human bones into the rubbish heaps with those of beasts and fishes (Lubbock, *Prehistoric Times*, p. 232). The discovery of some few ancient human remains, the state of which seems to indicate that the flesh had been eaten, may perhaps be taken to show that prehistoric savages were in this respect like those of modern times, neither free from cannibalism nor universally practising it. During later ages, it may have even increased rather than diminished with the growth of population,—its greatest excesses being found among high savage tribes or nations above the savage level. But with the rise of civilization to its middle and upper levels, it is more and more kept down by the growing sense of the dignity of man, and eventually disappears, as we may hope, irrevocably. (E. B. T.)

CANNING, George (1770–1827), one of the greatest of English statesmen and orators, was born in London on the 11th April 1770. He was descended from an ancient family; but his father, having incurred the displeasure of his parents, was cut off with a scanty allowance, and obliged to try his fortune in the metropolis. Here he studied for the bar, but literature proved too attractive for him, without yielding him even a tolerable livelihood. His affairs were not improved by a marriage with an Irish lady, of good connections and some beauty, but as poor as him-self. He died of a broken heart, a year after the birth of his son. The widowed mother took to the stage without achieving any great success, and in this new way of life married twice,—neither time wisely.

It was thus, in the society of the stage, that the future premier of England passed his earliest years. It was well for him, therefore, when one of his paternal uncles, a wealthy banker in London, took upon himself the care of his education. Young Canning was then in his eighth year, and from that time had all the advantages of the best education and the most cultured society, for Burke, Fox, Sheridan, and other leading Whigs were guests at his uncle's house. After spending a few years at a London school he went in due time to Eton and Oxford. At both places he highly distinguished himself. He was a brilliant scholar, gave promise of the future orator in the debating societies, became known as a wit in a wide circle of admiring friends, and even at Eton, at the age of sixteen, gave decided evidence of literary talent, in a periodical got up amongst his schoolmates. From Oxford he returned to London with the reputation of a man able to perform great things. And now he had to choose between two careers, not easily to be combined by one who had his own way to make in the world. The generous enthusiasm of youth tempted him into a political career; worldly prudence pointed him to the bar as the safer profession for a man without means. Circumstances decided in favour of the former. Pitt was now being drawn into the terrible crusade against the French Revolution, and greatly needed able associates to make head against the fiery eloquence of Fox and Sheridan. To Canning, who soon became known in the clubs and other political circles of the metropolis as a young man of the most brilliant promise, he made the offer of the nomination borough of Newport. This was accepted, and Canning entered Parliament as an adherent of Pitt in 1793, being twenty-three years of age.

Canning is charged with having taken this step from interested motives. In the debating societies of Oxford and the metropolis he had been an enthusiastic Liberal, and had long been the friend of the Liberal leaders. Now, when the prospects of the Whig party were becoming gloomier every day, this crossing over to the ranks of Pitt had a suspicious appearance of convenience. But there is no real ground for such suspicion. With regard to the French Revolution, which was now the all-absorbing political question, Canning simply underwent the same change of opinion as the immense majority of educated Englishmen, Pitt included, hailing it at first as the dawn of a new day for France and Europe, but turning away from it in dismay and indignation, and determined to oppose it, when he saw it was more likely to subvert than to reform society.

From his entrance into Parliament till the death of Pitt in 1806, Canning was an ardent and devoted supporter of all the measures of that statesman. In the House of Commons he soon took his place as one of the most brilliant and successful debaters of the time, though unhappily his efforts needed to be directed against his own friends, Fox and Sheridan; and he gave proof of his business capacity in some of the less prominent departments of the administration. Out of Parliament he fought the Revolution almost as effectively by starting (in 1797) the *Anti-Jacobin*, a weekly paper, in which the principles of innovation in morals, in literature, and above all, in politics, were mercilessly attacked, and their advocates covered with ridicule and abuse. Canning contributed many of the humorous articles, and in this way extended the reputation for caustic wit he had already acquired in Parliament.

In 1800 Canning married Miss Joan Scott. The marriage was in every way a happy and a fortunate one, based on mutual love and esteem, which continued unbroken to the end; while Miss Scott had a large fortune, and was connected with some of the highest of the aristocracy.

On the death of Pitt in 1806, and the formation of a Whig ministry by Fox and the Grenvilles, Canning went into opposition, and showed that, even on a question of humanitarian interest, he was not above the pettiest feelings of party. He supported, but very coldly, the bill for the abolition of the slave-trade.

against the armies of the French conqueror. He encouraged the spirit of resistance in the Spanish nation, supported the Spanish armies, first with supplies of arms, and then with the active co-operation of the English forces, and was one of the first to recognize and employ the military capacity of the future duke of Wellington. Unfortunately, an event soon occurred which deprived the country of his services, when the need was greatest, and when he was the only statesman in England whose talents were of the first order. In 1809, Lord Castlereagh, as Secretary-at-War, had organized the expedition to Walcheren, the worst conducted and the most disastrous of the whole war. In consequence of it a dispute arose between his lordship and Canning, which resulted in a duel, and in the resignation of both. From this unfortunate incident till 1822, Canning took no very prominent part in the Government of the country. This is particularly to be regretted, as the period in question includes the decisive years of the Napoleonic struggle, and the new settlement of Europe by the peace of Vienna, when Canning might have done good service by insisting, more than was done, on the claims of nationality and constitutional liberty. In this he was not free from blame, as he allowed his personal dislikes too much to interfere with his duty to his country. But the chief reason was his advocacy of Catholic Emancipation, which lost him favour at court Men's motives must always remain to some extent doubtful; still it seems clear that at one time his dislike of Castlereagh, at another his insistance on Catholic Emancipation, prevented him from resuming his place in the Foreign Office. He lived to regret this deeply, and to declare that two years of office at the termination of the European struggle would have been worth ten years of life. Even now, however, he was not idle. In 1812 he made a powerful speech in favour of Emancipation, which was carried in the Commons by a large majority, but rejected by the Lords. From 1814 to 1816 he was ambassador at Lisbon, and from 1817 to 1820 President of the Board of Control for India As a member of the Cabinet during the latter period he was very active in support of Government, strongly advocating the coercive measures employed at home during the years which immediately followed the Revolution. It is indeed a noteworthy fact in his political career that, though unable to act with Castlereagh in the most dangerous crisis of the French war, he found it right to join him and his associates in such severe measures of repression,—noteworthy, but quite explicable, as Canning never professed to be anything else than a disciple of Pitt.

At the head of the Board of Control, Canning gained the entire confidence of the directors of the East India Company. In consequence, they had appointed him to the governor-generalship of India, and he had proceeded to Liverpool to take leave of the constituents who had four times returned him to Parliament, when news came of the death of Castlereagh (then earl of Londonderry). The voice of the country had already named him successor in the Foreign Office, and, in this capacity, under the premiership of Lord Liverpool, Canning entered upon the last and most brilliant period of his career. The state of Europe had greatly changed since his resignation of the same office in 1809. The Holy Alliance now aspired to regulate the affairs of the world. Inaugurated by the emperor of Russia, under the inspiration of Madame Krudener, it was at first a sincere attempt of the rulers of Europe to govern on Christian principles. But even the Russian emperor was soon frightened from the path of benevolent reform by the revival of the revolutionary spirit and its appearance in his own army; while interested statesmen like Metternich so utilized the pious aspirations of kings to the profit of despotism, that the Holy Alliance soon became a byword in Europe. Castlereagh had yielded too far to this tendency. The country was getting weary of it. And now Canning came forward to assert the free action of England and the universal right of self-government. He was, however, no revolutionist. In his home and foreign policy alike he aimed at holding a middle course. At home he advocated Catholic Emancipation, and believed in Free Trade, but strenuously opposed Parliamentary Reform. In his foreign policy his principle was that England should hold the balance between the reactionary and the revolutionary parties, "that in order to prevent things going to extremities, she should keep a distinct middle ground, staying the plague both ways." Seeing that the reactionary party predominated in 1822, he judged that England should throw the weight of her influence into the Liberal scales. In accordance with these views, he protested against the doctrine that free institutions should be held only as a spontaneous gift of the sovereign, and disapproved of the measures adopted at the Congress of Verona in 1822, especially of the French invasion of Spain for the restoration of absolutism in 1823,—a year, too, which was marked at home by the passing of the Reciprocity Act, the first step in the direction of Free Trade. In order to render the protest against the invasion of Spain more effectual, it was determined in 1824 to recognize the independence of the South American colonies. On the threatened invasion of Portugal by reactionary Spain in 1826, Canning again interposed with the utmost decision, and the invasion was abandoned. The speeches he made on these occasions, and his general attitude of defiance to despotism, had a marvellous effect, not only in Parliament and in England, but in all civilized communities. He was everywhere hailed as the champion and spokesman of national and popular liberty. The party of progress recovered from the torpor consequent upon the Revolution, and returned to new life. The enthusiasm for his name was heightened when it became known that he had taken the initiative in another act of international justice, by proposing (1826) to France and Russia that combination of the three Powers which led to the battle of Navarino and the establishment of Greek independence.

But ere that result had been attained the great statesman was no more. Early in 1827 Lord Liverpool, who had been the nominal head of the Government since 1812, was disabled Canning, who now became premier, expected the co-operation of the members of the late administration, but was disappointed, and had to struggle on under the greatest difficulties, and against the most virulent opposition. His exciting labours and the alienation of so many friends were too severe for his sensitive temperament. He caught a severe cold, and died on the 8th of August 1827. He was buried in Westminster Abbey, in the Statesmen's Corner, by the grave of his master Pitt.

His death created a sensation commensurate with his world-wide fame and with the hopes still entertained of him. The splendour of his talents was only matched by their versatility. In his high and brilliant career he had proved himself equal to anything—from guiding the destinies of a great nation through the storms of the Napoleonic wars, down to the editing of a comic journal. He had all the natural endowments of a great orator,—a graceful and commanding form, a musical voice, a perfect mastery of the choicest language, and a ready wit that played with all the resources of his intellect. In private life he was even more admirable,—in his own family an almost perfect model of all the household charities, and towards his mother, whose imprudent marriages had endangered his infancy, full of the tenderest and most affectionate piety. (T. K.)

CANNING, CHARLES JOHN, EARL AND VISCOUNT (1812-1862), Governor-General of India, was the youngest child

of the subject of the preceding notice, and was born at Brompton, near London, on the 14th December 1812. He was educated at Christ Church, Oxford, where he graduated B.A. in 1833, as first class in classics and second class in mathematics. In 1836 he entered Parliament, being returned as member for the town of Warwick in the Conservative interest. He did not, however, sit long in the House of Commons; for, on the death of his mother in 1837, he succeeded to the peerage which had been conferred on her with remainder to her only surviving son, and as Viscount Canning took his seat in the House of Lords. His first official appointment was that of Under-Secretary of State for Foreign Affairs, in the administration formed by Sir Robert Peel in 1841,—his chief being the earl of Aberdeen. This post he held till January 1846; and from January to July of that year, when the Peel administration was broken up, Lord Canning filled the post of Commissioner of Woods and Forests. He declined to accept office under the earl of Derby; but on the formation of the Coalition Ministry under the earl of Aberdeen in January 1853, he received the appointment of Postmaster-General. In this office he showed not only a large capacity for hard work, but also general administrative ability, and much zeal for the improvement of the service. He retained his post under Lord Palmerston's ministry until July 1855, when, in consequence of the death of Lord Dalhousie, and a vacancy in the governor-generalship of India, he was selected by Lord Palmerston to succeed to that great position. This appointment appears to have been made rather on the ground of his father's great services than from any proof as yet given of special personal fitness on the part of Lord Canning. The new governor sailed from England in December 1855, and entered upon the duties of his office in India at the close of February 1856. His strong common sense and sound practical judgment led him to adopt a policy of conciliation towards the native princes, and to promote measures tending to the betterment of the condition of the people.

In the year following his accession to office the deep-seated discontent of the people broke out in the mutiny which grew into the Sepoy War. Fears were entertained, and even the friends of the viceroy to some extent shared them, that he was not equal to the crisis. But the fears proved groundless. He had a clear eye for the gravity of the situation, a calm judgment, and a prompt, swift hand to do what was really necessary. By the union of great moral qualities with high, though not the highest, intellectual faculties, he carried the Indian empire safely through the stress of the storm, and, what was perhaps a harder task still, he dealt wisely with the enormous difficulties arising at the close of such a war, established a more liberal policy and a sounder financial system, and left the people more contented than they were before. While rebellion was raging in Oude, he issued a proclamation declaring the lands of the province forfeited; and this step gave rise to much angry controversy. A "secret despatch," couched in arrogant and offensive terms, was addressed to the viceroy by Lord Ellenborough, then a member of the Derby administration, which would have justified the viceroy in immediately resigning. But from a strong sense of duty he continued at his post: and ere long the general condemnation of the despatch was so strong that the writer felt it necessary to retire from office. Lord Canning replied to the despatch, calmly and in a statesman-like manner explaining and vindicating his censured policy. In April 1859 he received the thanks of both Houses of Parliament for his great services during the mutiny. He was also made an Extra Civil Grand Cross of the Order of the Bath; and in May of the same year he was raised to the dignity of an earl. By the strain of anxiety and hard work his health and strength were seriously impaired; and in the hope that rest in his native land might restore him, he left India, reaching England in April 1862. But it was too late. He died in London on the 17th of June following. About a month before his death he was created K.G. As he died without issue the title became extinct.

CANNON. See GUNS AND GUNNERY and ARTILLERY.

CANO, ALONZO (1600–1667), one of the most vigorous of the Spanish painters, and also, like Michelangelo, with whom he is usually compared, an architect and sculptor of great merit. He has left in Spain a very great number of specimens of his genius, which display the boldness of his design, the facility of his pencil, the purity of his flesh-tints, and his knowledge of chiaroscuro. He was a native of Granada, and a contemporary of Velasquez and Pacheco, whom he rivalled without imitating. As a statuary, his most famous works are the Madonna and Child in the church of Nebrissa, and the colossal figures of San Pedro and San Pablo. As an architect, he indulged in too profuse ornamentation, and gave way too much to the fancies of his day. Philip IV. made him royal architect and king's painter, and gave him the church preferment of a canon. He was notorious for his ungovernable temper; and it is said that once he risked his life by committing the then capital offence of dashing to pieces the statue of a saint, when in a rage with the purchaser who grudged the price he demanded. His known passionateness also (according to another story) caused him to be suspected, and even tortured, for the murder of his wife, though all other circumstances pointed to his servant as the culprit.

CANO, or CANUS, MELCHIOR (1523–1560), a learned Spanish bishop and theologian, who was pupil and successor of Vittoria as professor of theology at Salamanca. He had one, and only one, rival as to erudition in Spain, Bartolomeo de Carranza, like himself a Dominican, and the university was divided between the partizans of the two professors. On account of his violent opposition to the establishment of the Jesuits in his native country, he was summoned by Pope Paul III. to the Council of Trent, and appointed to the distant see of the Canaries. But his influence with Philip II. procured his recall to Castile, where he became provincial of the Dominican order. His principal works are entitled *Prælectiones de Pœnitentia*, *De Sacramentis*, and *Locorum Theologicorum Libri XII.*

CANOE, a species of boat. In several Eastern languages the word *kan* means something hollow, with a certain degree of strength. Pliny says some Indian reeds are long enough to form a boat for three men between the joints. The French *canot*, Spanish *canoa*, Italian *canoe*, are derived from the Latin *canna*; but a canoe is sometimes called in France *bateau*, *bac*, *pirogue*, *caïque*, *chaloupe*, *navire*, *nacelle*, or *périssoir*, and the paddle *pagaye*, and the canoeist *pagayeur*. The English word "canoe" may be defined as a boat propelled by one or more paddles used without a fixed fulcrum on the boat, and therefore invariably with the sitter facing towards the bow. The Venetian gondola and the Maltese boats, and many others, are rowed by men who face the bows, but they always have a fixed rest for the rowlock. Canoes are made of various substances. Those of the Esquimaux are of seal-skin stretched over whalebone, and are propelled by the double-bladed paddle, 7 feet long and 6 inches broad, used by one man, whose dress is united with the deck covering, so as to be watertight.

The North American "dug-out" canoe is made from a tree hollowed by fire, while the bark canoes are formed by birch bark sewn together, according to the size required, until the craft will hold as many as seventy men. Paper canoes have been used in the United States. Cork leather

would probably be a very good material. Canoes of tin and of india-rubber have been used in England, but practically all the best canoes now built in England, America, and France for general travelling are of oak, cedar, or pitch pine. The canoe was popular in England more than twenty years ago at Oxford and Cambridge, but only for short river practice, until in 1865 one was specially designed for a long journey by water in seas, lakes, and rivers, and by carriage on land in railways or carts or on horseback, or by being dragged over rough ground or borne on men's shoulders through woods and over hills.

The general type of this "Rob Roy" canoe is built of oak with a cedar deck. The length is from 12 to 15 feet, and the beam from 26 to 30 inches, the depth 10 to 16 inches. The paddle is 7 feet long with 6 inches of breadth in the blade, and is either double-bladed, or, if it is used with a single blade, a rudder is worked by the foot to counteract the lateral swerving. A backboard swinging with the paddler's motion enables the canoeist to sit in a comfortable position for many hours at a time, and a mast with some light sails completes his equipment, so that a favourable wind eases the muscular exertion. An ordinary travelling canoe when complete weighs about 70 lb. It will float with its paddle and 10 lb of luggage in 5 inches of water. In the Indian canoes of America the single paddle is usually employed, and the men kneel to the work. The canoeists in the Straits of Magellan paddle standing. The peculiar advantages of a canoe may be summed up thus:—

1. The canoeist faces forwards in the direction of his progress, and therefore he can readily steer without turning his head round.

2. His centre of gravity is five or six inches below what would be necessary in a row-boat, and therefore the canoe is more steady, and is very suitable for shooting from. When the action of the paddle stops the canoeist is at once in comfortable rest. In descending a rapid where rocks or snags are numerous, the canoeist has much power of seeing and avoiding danger, while he can also get out readily, and can sit on the deck in places where the feet, being in the water, are of service in warding off collisions.

3. The knees of the canoeist press outwards against the sides of the "well" or opening in the deck, so that in high seas there is ample "purchase" for counteracting an upset, while the canoeist can use great power with his paddle at a critical moment for lifting the craft over a wave. The alternate action of the arms opens the chest, and the legs are continually exercised by pressure against the stretcher, while the sway of the whole body at each stroke of rowing is dispensed with.

4. He can instantly hoist sail without leaving his place or shifting ballast, and he can fish or shoot conveniently without changing his seat. He can sleep in the canoe when it is properly prepared.

5. The canoe being impelled without rowlocks, by pressure through the legs to the feet resting on the stretcher, and by only one implement (the paddle), the joints of the planks and the nails and fastenings, are not loosened, as in other boats, by the jerky leverage of rowlocks.

6. The deck covering (not feasible in a row-boat) protects the paddler and his luggage from wind, rain, and sea, and adds to the "stiffness" of his craft, so that it can be dragged on rough ground without injury. A canoe should have a very flat floor and small keel; this secures stability, while it diminishes speed to a very small extent.

7. Ladies and young children can conveniently use the canoe because of its safety and the simplicity of its mode of propulsion. Many double canoes are used in England, and some with four paddlers together.

For actual speed over a short and straight course the ordinary sculling skiff is superior to the canoe, but for long journeys of more than a week's duration, and in strange rivers, or with frequent portage, rough usage, intricate navigation, or unexpected difficulties, the canoe is found to be much more convenient than the rowing boat. Forty miles a day in lakes can be kept up for weeks together in a travelling canoe, unless against a contrary wind. Fast racing canoes are 20 feet long and 18 inches broad, and attain a speed of 8 miles an hour. Canoes for "upset races" (where the canoeist has to jump out, tow his boat while swimming, and then get in) and for the race "over land and water" are specially built for their purpose. Other canoes are built chiefly for sailing, and these carry "drop keels," "rockers," and heavy ballast.

In 1866 the Royal Canoe Club was formed in England, and the Prince of Wales became commodore, while about 500 members have been elected in various parts of the world. After the English canoes were seen in Paris at the Exhibition of 1867, others like them were built in France. Branches and clubs were formed also at the English universities, and in Liverpool, Hull, Edinburgh, Glasgow, and New York. A publication called *The Canoeist* records the more important cruises in canoes in almost every country on the globe. One member of the club crossed the English Channel from Dover to Boulogne in his canoe, another from Boulogne to Dover, and a third crossed the Irish Channel from Scotland to Ireland. Many old and new rivers have been explored for the first time in canoes, among which the most interesting were the hitherto inaccessible parts of the Jordan, the Kishon, and the Abana and the Pharpar at Damascus, as well as the Lake Menzaleh in the Delta of the Nile, and the Lake of Galilee and Waters of Merom in Syria. So far as has been ascertained, not one of the members of the Royal Canoe Club has been drowned in any of the numerous long cruises performed.

See Macgregor's *A Thousand Miles in the Rob Roy Canoe*, *The Rob Roy on the Baltic*, and *The Rob Roy on the Jordan, Red Sea, Nile, and Gennesareth, &c.*; *Canoe Travelling*, by W. Baden Powell; *Cruise in a Cockle Shell*, by A. H. Reed; *The Canoeist* (Royal Canoe Club). (J. M'G.)

END OF VOLUME FOURTH.